













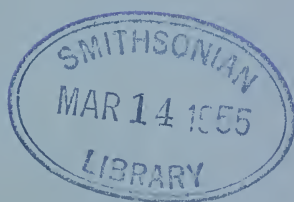




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# THE VIRGINIA JOURNAL OF SCIENCE

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JANUARY, 1955

No. 1

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### *Author's Correction*

Grayson, J. M. and D. G. Cochran — On the Nature of Insect Resistance to Insecticides. *Va. Jour. Sci.*, 6 (3): 134-145

p. 138—last line should read “complex inheritance in house flies.

*Pimentel et al.* (1954) found the progeny from reciprocal crosses of DDT-resistant and non-resistant house flies to be intermediate in resistance between the parents; and the female to influence the progeny more than the male even though the resistance was not sex linked. In addition, Johnston *et al.* (1954) have ”.

p. 139, line 15. should read “factor manner (King, 1954; Crow, 1954).”









# THE VIRGINIA JOURNAL OF SCIENCE

VOL. 6, NEW SERIES

JANUARY, 1955

No. 1

## Edgar Calvin Leroy Miller, M.D.

1867-1954

Dr. Edgar Calvin Leroy Miller, one of the founders of the Virginia Academy of Science in 1923 and *The Virginia Journal of Science* in 1940, died at the home of his younger daughter, Mrs. Gwendolyn L. Bowman, in San Diego, California, on July 21, 1954, at the age of 86. For twenty-six years, he contributed his time as secretary-treasurer of the Academy to build up this organization to its present respected reputation in Virginia and throughout the country. No scientist in the Old Dominion has ever done more for organized science on a state level than Doctor Miller. Because of this contribution, he was considered to be the dean of the Academy Conference of the American Association for the Advancement of Science, made up now of 42 academies of science. His counsel was constantly being sought by other academies to try to find out why "his academy" was so successful.

Born in Pelham, Massachusetts, in 1867, Doctor Miller was graduated from the Nebraska State Normal School in 1887. He then spent several years studying theology at Oberlin College and planned with his future wife, Lillian Belle Carpenter, careers as medical missionaries. They married in 1890 and both entered the medical school of the University of Michigan. He was awarded his M.D. degree in 1894 and then was an instructor for one year. His wife's degree was delayed one year by the birth of a son. In 1895, both Doctors Miller left for Bilaspur, India, where they served as medical missionaries for five years. Returning to this country in 1900, he joined the research staff of Parke, Davis and Company and helped to develop this organization's manufacture of biological preparations. He was sent to Europe in 1906-1907 and visited most of the scientists doing investigative work in this field. His development of diphtheria antitoxin manufacture for his company and his papers in medical periodicals of that time about the manufacture of "biologicals" won for him an international reputation when he was 40.

His "classes" at Parke, Davis and Company on new techniques having to do with the preparation of bacterial vaccines attracted physicians and laboratory men from this country and abroad. Doctor Miller liked to teach, and he was a "natural" in this field, so when an offer came to him from the University College of Medicine (a few years later consolidated with the Medical College of Virginia) in 1911 to become professor of bacteriology he gladly accepted it, even though his decision involved a substantial financial sacrifice. Successful in the medical missionary field,

outstandingly so in the commercial world, Doctor Miller began his climb to remarkable successes in the fields of medical education and organizational procedures. First of all, he established the department of biochemistry at the Medical College of Virginia in 1913 and also became custodian of what was then called the "college library" in the Virginia Hospital which was then a nurses' home. He was dean of the Medical College of Virginia School of Medicine for one year, 1920, but soon "recovered from that" as he often remarked with a twinkle in his eyes. More to his liking was a nonprofitable connection with the American Illustrated Medical Dictionary which he made in 1922 with the publishers, W. B. Saunders and Company. He enjoyed this editorial work for many years.

Then came 1923 and the organization of the Virginia Academy of Science. Dr. Miller was elected secretary-treasurer at the organizational meeting of the Academy at the College of William and Mary on April 26, 1923 and continued in this office until May, 1949, when he requested that his resignation be accepted. He agreed to serve as secretary emeritus and acted in this capacity until his death. There was none of Doctor Miller's innumerable activities which he loved more than his work for the Academy. He was overjoyed when the annual E. C. L. Miller Award for an outstanding science club of the State was initiated, not because his name was attached to it but because he had always been intensely interested in encouraging high school students with apparent aptitudes for scientific careers. When his many friends of the Academy and others cooperated to present him with his likeness in oil in 1948, he wept and kept still. Said Dr. Ivey F. Lewis in his presentation talk: "I think it may fairly be said of Doctor Miller as of Sir Christopher Wren, the famous architect who rebuilt London after the Great Fire of the 17th Century and whose influence extended to Virginia, 'If you would see his monument, look around you'."

Although officially professor of bacteriology, Doctor Miller and his able associate, Professor Robert F. McCrackan, and two assistants taught all the biochemistry at the Medical College of Virginia from 1913 to 1927. In 1929, he relinquished the chair of bacteriology and in 1930 was appointed full-time director of the library. With more time for library planning, he started up the hill again at 63 in what amounted to his fifth major undertaking. Starting with a small reading room and a few stacks, on the first floor of McGuire Hall, containing comparatively few books and periodicals, Doctor Miller, with the encouragement of the administration and the assistance of Florence McRae, Margaret McCluer, and Virginia Staub Young, built up one of the leading libraries in the South specializing in literature pertaining to the health fields. Doctor Miller was never a joiner of social clubs but in the early days of the Medical College of Virginia library he was probably the world's greatest joiner of scientific organizations in this country and abroad. He contended that it was much cheaper obtaining scientific journals this way than it was by subscriptions! He also helped to establish the library of the American Tobacco Company Research Laboratory. Almost until his death, he translated articles from several different languages for this library. Doctor Miller

retired in 1947. When he passed away, he was Secretary Emeritus of the Virginia Academy of Science and Librarian Emeritus of the Medical College of Virginia. President William T. Sanger said upon learning of his death: "Doctor Miller's contribution to the Medical College of Virginia both as a professor and librarian was so great it could not be evaluated."

Besides a highly successful life, he enjoyed an interesting one. He always said he was introduced to science by his professor of biology at Nebraska State Normal School who gave him a project during the summer of 1884 of classifying all the snakes in the neighborhood with the request that he capture a specimen of each variety! Once, in India, Doctor Miller suffered from a toothache. He was miles from a dentist so he cleaned out and filled one of his back upper molars with an amalgam made from a coin of the realm, using mirrors to do the job. With his keen and subtle sense of humor, he often remarked that this was the only tooth he ever lost! When it was rumored during World War I that the Germans were adding powdered glass to certain American food supplies, Doctors Miller and Charles C. Haskell fed glass to dogs and swallowed some themselves. They came up with the conclusion, which was widely publicized at the time, that powdered glass that could be taken in food produced no noticeable symptoms in either in dogs or humans. (Subsequently Doctor Miller turned the tide in several lawsuits in the country involving suits for damages by individuals who claimed to have swallowed glass in soft drinks, cheese, frankfurters, ice cream, and other products.) He enjoyed corresponding with scores of individuals whom he had never seen about everything under the sun — astronomy, psychology, segregation and even the servicing of trains and often wrote the authors of published articles with which he agreed or disagreed. After the age of 80, he "discovered" oceanography and read all he could find on the subject.

He enjoyed a happy life because he was never too busy to help someone else in trouble — whether it was weather-stripping a house or talking a person out of despondency. In 1918, he responded to the urgent need for trained workers and offered his services to the Federal Food Administration to help with nutritional problems in Richmond and also became a member of the Volunteer Medical Corps authorized by the Council of National Defense. He was director of the emergency hospital set-up in the John Marshall High School, Richmond, Virginia, in October 1918, to care for patients at the height of the influenza epidemic.

Doctor Miller's publications in scientific periodicals had to do with a wide variety of subjects. Miss Margaret McCluer, the present librarian of the Medical College of Virginia and staunch admirer of her former director, has recently compiled a list of them which she can't be sure is complete. The subjects range from "On the Keeping of Antidiphtheritic Serum" in 1905 to "The Virginia Academy of Science Research Endowment" in 1943. Not until after his death did his immediate family know the extent of his publications!



The activities of Doctor Miller were so diversified that he never had time to be bored and he was rarely upset. When he did become upset, one could be almost sure that it had to do with someone's stupidity or deliberate injustice. He never could tolerate either. His favorite words were "vision" and "change" and with them he lived. There are all kinds of ways of walking with God—certainly this truly great scientist and selfless gentleman, whose life was given devotedly to the service of his fellowman, walked with Him in his way.

---

#### NOW, THEREFORE, BE IT RESOLVED

- (1) THAT the Virginia Academy of Science will forever honor Dr. E. C. L. Miller for his devoted service as its secretary-treasurer for twenty-six years, 1923 to 1949, and
- (2) THAT the Virginia Academy of Science will always be grateful to him for assisting in the establishment of The Virginia Journal of Science in 1940, and
- (3) THAT the Virginia Academy of Science recognizes his outstanding accomplishment in being lately responsible for the organization of the Virginia Junior Academy of Science in 1940, and
- (4) THAT the Virginia Academy of Science honors him for his unique contribution to the scientific welfare of the Old Dominion and the Nation, and
- (5) THAT the foregoing resumé of Dr. Miller's career and this resolution be made a part of the permanent records of the Virginia Academy of Science and published in the January, 1955, issue of *The Virginia Journal of Science*, and
- (6) THAT copies of the issue of the Journal containing the foregoing resumé of Dr. Miller's career and this resolution be obtained from *The Virginia Journal of Science* and sent to Dr. Miller's four children,

Mrs. Gwendolyn L. Bowman, 4789 Dwight Street, San Diego, Calif.;

Mr. Leland H. Miller, Box 85, Atascadero, Calif.;

Mr. Louis Miller, 208 Ini Way, Aiea, Oahu, Hawaii;

Mrs. Geraldine M. Duncan, 2915 Seminary Ave., Richmond, Va.

Respectfully submitted,

(Signed) Sidney S. Negus

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NOTE: This resolution was passed unanimously by a rising vote at a meeting of the Council of the Virginia Academy of Science in Lexington, Virginia, October 31, 1954.

(Signed) Irving G. Foster, President

## Sinews of Science

C. E. SUNDERLIN

*Deputy Director, National Science Foundation*

### PROGRESS IN SCIENCE

The Mountain Lake Biological Station was established just 25 years ago. It is of special interest, therefore, to recall some of the achievements in science since 1929, a year when uncertainty and depression began to have their temporary effects on American life. An outstanding event that we witnessed during this period was the destruction of the nuclei of atoms. This feat has since been surpassed by a reversal of the process in that most terrible of all weapons, the hydrogen bomb, in which the nuclei of atoms are fused together. We have also witnessed astonishing developments in the plastics and synthetic-fiber industries; in the conquest of many types of illness and disease with the discovery of sulfa drugs and the various antibiotics, the synthesis of vitamins, and the discovery of new vaccines. The sound barrier has been broken and the jet age is upon us. Very recently there has been the announcement by Professor Marcel Schein of the University of Chicago that he has found evidence for the existence of contraterrene matter in the upper atmosphere. This discovery of the existence of particles of matter with negatively charged nuclei and energies of a million billion electron volts is perhaps one of the most important of the discoveries made in these 25 years of progress in science.

In view of the remarkable progress in science—progress that every year seems to be accelerating—it may be appropriate to pause to examine those factors that are responsible for a strong and virile science. We might think about them in the light of the dictionary definition of the word “sinew”, a word which elicits connotations of strength and elasticity and durability. The word “sinew” means a tendon, or less often a nerve, or a muscle. It also means “that which supplies strength or power”. What then are the factors which supply strength or power to science, and especially to science in the United States? And conversely what are the weaknesses—the degenerative diseases of muscle and tissue—that threaten our science of today?

The sources of strength may be summarized as follows:

- (1) The *individual* who has the capacity for becoming a productive scientist.
- (2) *Training*, without which this potential could never be realized.
- (3) *Opportunity* for research, so that the trained scientist can make maximum use of his abilities.

---

**Editor's Note:** We are pleased that Mr. C. E. Sunderlin has permitted us to publish this article which is based upon remarks made at the Twenty-fifth Anniversary of the Mountain Lake Biological Station, University of Virginia, July 17, 1954.

(4) *Communication* among scientists, so that ideas can be generated in full knowledge of what has gone before and of the work in progress.

Our failure to realize the full potential of these sources of strength is a principal cause of weakness, which, if unremedied, may permit a wasting away of the tough fiber of the tendon or "sinew" of science. I should like to discuss each of these sources of strength briefly and to indicate how the Federal Government is helping to build muscle tissue, and to strengthen the tendons of science.

### THE INDIVIDUAL SCIENTIST

Science is peculiarly the creation of scientists, in some instances existing only in their heads. Scientists, as human beings, and also as scholars, therefore, come in for extraordinary scrutiny. What are the qualities which the individual scientist should or must have? What are the innate characteristics which must be possessed by the individual before training and opportunity can assist in his development as a creative scientist? I know of no other class of scholars—historians, economists, sociologists—whose personal characteristics have been so minutely scrutinized and analyzed. Perhaps this is because, as G. K. Chesterton once aptly put it — and this many years before the atomic bomb—:

Men find it extremely difficult to believe that a man who is obviously uprooting mountains and dividing seas, tearing down temples and stretching out hands to the stars, is really a quiet old gentleman who only asks to be allowed to indulge his harmless old hobby and follow his harmless old nose. When a man splits a grain of sand and the universe is turned upside down in consequence, it is difficult to realize that to the man who did it, the splitting of the grain is the great affair, and the capsizing of the cosmos quite a small one. It is hard to enter into the feelings of a man who regards a new heaven and a new earth in the light of a by-product. But undoubtedly it was to this almost eerie innocence of the intellect that the great men of the great scientific period, which now appears to be closing, owed their enormous power and triumph. If they had brought the heavens down like a house of cards, their pleas was not even that they had done it on principle; their quite unanswerable plea was that they had done it by accident. Whenever there was in them the least touch of pride in what they had done, there was a good ground for attacking them; but so long as they were wholly humble, they were wholly victorious.

Small wonder, then, that the rest of mankind wants to know, with a great deal of interest and not a little suspicion, what the "quiet old gentleman" is really like.

Several years ago, a psychologist, Dr. Anne Roe, under a grant from the United States Public Health Service, undertook a serious study to determine the factors that contribute to scientific greatness. She based



her study upon an analysis of some 60 pre-eminent scientists—about 20 in biology, 20 in the physical sciences, and 20 in the social sciences. In addition to the scientific papers in which she has published her findings, Dr. Roe has also published a popular book, *The Making of a Scientist*. Dr. Roe's book is enjoyable reading, particularly for scientists, because, of course, it is always interesting to see ourselves dissected and analyzed in so painstaking a fashion.

It is significant that after her extensive study, Dr. Roe (1953) concludes:

One thing seems clear. Scientists are people, not rational automats. They differ from other people in terms of what they do, in the things that give them satisfaction, more than in terms of completely special capacities. There is nothing you can say about them as persons that you cannot also say about some people who are not scientists. And there is almost nothing you can say about a man in some particular field of science that you can not also say about someone in another field of science.

Dr. Roe does find, however, that scientists tend to have many things in common; so that in studying their lives, one finds patterns in their backgrounds, in their intellectual abilities, in their personality structure, and so on. Such traits as native intelligence, imagination, and ingenuity are essential. In addition, however, the individual must have the attributes of curiosity and skepticism.

Curiosity is a quality different from imagination. It is a habit of mind, a driving force that permits the exercise of intelligence and imagination in the solution of a particular problem. Curiosity is a strongly motivating factor—it is undoubtedly responsible for the selection of a scientific career by many able and intelligent students, who wish to know and understand the causes of the natural phenomena in the world around us. They wish to understand and explain the origin of the species, genetic variability, the attraction of physical bodies, the nature of the atom, the motions of the stars, the structure of the universe.

To curiosity must be added skepticism, the attitude of mind that takes nothing for granted, which demands proof of statements, beliefs, hypotheses, and laws. The true scientist is a skeptic, a doubting Thomas in the best sense of that phrase. He is, also, more often than not, a non-conformist in his thinking. As *Fortune* (Bello, 1954) pointed out in a recent article:

The scientist, particularly the most gifted, is, by almost any definition, a maverick. His endowments, drives, interests, political opinions, and even religious beliefs are not, in most cases, those of the majority of society. In the total population of the U. S. the scientist is at most one in 3,000, and if the term scientist is reserved for only the independent investigator, on whom virtually all scientific progress depends, the ratio is more like one in 30,000.

As more and more emphasis is placed on conformity, there is less and less room for the brilliant individual of unconventional thinking. This is a country to which the maverick has contributed a great deal, and it would be a great pity if we were to deprive ourselves of his unpredictable gifts.

### TRAINING OF SCIENTISTS

The training of a scientist never ceases—if he is to remain a scientist. There are, however, certain recognizable periods during which the process of training is rigorous and intensive. In the university and in the graduate school this is particularly true, and to a lesser degree in high school. There are thus three times of decision when a critical choice is made, determining in each case a series of events in the career of the potential scientist.

The first of these is the most uncertain of the three. It comes at a time when the interest and curiosity of the student—often still in grade school—have been stimulated to such an extent that he is motivated toward scientific activities. Such a stimulus might come from an inspirational teacher, a science TV show such as the “Johns Hopkins Science Review,” or “Watch Mr. Wizard,” elementary descriptive books on natural phenomena such as those on plants and flowers and trees, written by experts in the Fish and Wildlife Service of the Department of the Interior. Whatever the reasons, at some indeterminate time the student makes this first decision that he will follow scientific pursuits. The decision has been based on a combination of knowledge, thought, and emotion, *and* an interest that is easily lost if the motivation is not kept alive. It is by no means a final decision. The way may be hard and enthusiasms die.

The second time of decision occurs at the transition point between high school and college. At this time the decision is harder for some and easier for others. In some cases there may be merging of first and second decisions. Many who would like to go on to college do not do so, however, for a variety of reasons. At the present time only one student in three who graduates from high school enters college. More important, 47 per cent of those high school students of high ability do not go on to college or university. The loss that occurs here is an undetermined loss that is a potential source of weakness, not only to sinews of science, but to all other fields as well.

The third time of decision occurs in the transition from undergraduate to graduate study. Science has become increasingly complex and specialized, and there is need for longer periods of training than in the days of Newton, Galvani and Galileo. In their times the body of cumulative knowledge was much smaller than it is now. Today, however, the young man or woman who is seriously contemplating a career in science knows that the B.S. degree is probably not going to be sufficient to advance him very far in research. A bronze plaque in the halls of Monmouth College reminded students of the oft-repeated words of their chemistry professor, William S. Haldeman: “The Bachelor’s degree is not enough.” The young scientist is beginning to acquire momentum at the time of his third decision and this momentum must be conserved.



The crucial nature of this transition point was kept in mind when the Foundation decided to emphasize first-year graduate fellowships in its fellowship program. On March 15 of this year announcement was made of the award of 220 first-year graduate fellowships, as well as 240 intermediate and 197 terminal-year fellowships in the sciences. There were also 79 postdoctoral fellowships.

In addition to support of training through fellowship programs, the training of students is aided through the grants and contracts for research at universities and colleges by such agencies as the Office of Naval Research, Atomic Energy Commission, National Institutes of Health, Department of Agriculture, and, of course, the National Science Foundation.

Before leaving the subject of assistance for graduate training, however, there is one note of caution that I believe should be sounded. Dr. Roe has pointed out that if opportunities for graduate training are *too* numerous and *too* easily available, some of the motivation to acquire such training may easily be destroyed. She reminds us that in harder times a sort of natural selection took place of those individuals who were strongly enough motivated to obtain their graduate training despite the difficulties involved. I believe that those of us who obtained our own training in the lean years of the depression would find it easy to agree with this premise.

Turning now to other elements that enter into the training of scientists, we should all probably agree that the teacher is a vital fiber, if not the most vital, in the sinews of training. His fund of knowledge and his capacity for inspiration permeate and infuse the whole of the educational process. The work of Professors Goodrich and Knapp of Wesleyan University has placed in bold relief the role of the teacher of science in our liberal arts colleges. Their studies show that certain of the small liberal arts colleges have distinguished records in graduating individuals who later obtain doctoral degrees in science. The proportion of their graduates who go on to careers in science is far greater than the average for the large universities. The fifty institutions that lead in the production of scientists include, among others, Reed College, Oberlin, Hope, Charleston (South Carolina), West Virginia, Wesleyan, Haverford, Montana State, and other comparatively small schools. Their success is attributed in large measure to one or two members of the science faculty of each institution. These teachers have the capacity for imparting knowledge in such a manner that the students become more than receptors; they develop the curiosity and skepticism so vital to a continued career in science.

The success of certain of these smaller institutions in inspiring careers in science points up a problem that is seldom discussed. This is the failure of the universities to stimulate a larger proportion of their undergraduates in science to continue as graduate students. This may be the result of preoccupation with their own research on the part of faculty members; the lack of a properly intimate environment for catalyzing interest in research as a profession; the failure to attract fine teachers because of undue emphasis upon the publication of research papers. Here again is a possible source of weakness for science, in spite of the outstanding

record of the larger universities in providing the graduate school environment so essential to advanced training in science.

The ideal situation, of course, is one in which both teacher and school are equally strong and effective. In the absence of the ideal, however, there can be little doubt that it is the teacher who is the crucial element in the development of young scientists.

### OPPORTUNITIES FOR RESEARCH

Opportunities for reasoned thought and investigation of problems in science are primarily limited by the imagination and ingenuity of the individual scientist. At the same time, however, the increasing complexity and specialization of science have created requirements for physical facilities and equipment undreamed of 25 years ago. We were not concerned at that time with high-speed particle accelerators, cryogenics, high-temperature and high-pressure research, upper-atmosphere research, and so on. Such studies as these have created logistic problems of substantial size. One wonders: Could the universities and colleges have financed research in these fields from their own resources?

Research in these fields is expensive in time, money, and materials. The universities have had to face an increasingly expensive economic world with a generally static income of lower purchasing power. The dilemma was before them in 1939 but was postponed temporarily by World War II and the concentration of scientific effort on war problems through the Office of Scientific Research and Development. In 1945 and subsequent years this dilemma was still present but was ameliorated by the actions of ONR, NIH and AEC in providing support for research in academic institutions.

Thus, pending the establishment of the National Science Foundation, other agencies of the government developed programs of research support in universities, research institutes and medical schools, not only to solve problems of direct concern to them, but to maintain a healthy and vigorous scientific effort in the country. This arrangement was not, and is not, altogether altruistic, nor is it a marriage of convenience. There was general recognition of two important facts: (1) the urgent necessity of maintaining our leadership in scientific research, and (2) the importance of increasing our capacity for performing basic research. The two are intimately related to national strength and national security.

Opportunities for research exist abundantly in the laboratories of the universities, industry, and government. The 20th-Century worship of the machine can be a source of weakness, however, if not tempered with the recollection that many great discoveries have come from relatively simple experiments and keen observation. Archimedes and his bathtub, Franklin and his kite, Bragg and his soap bubbles, Langmuir and his soap films, Powell and his nuclear emulsion plates are only a few of the examples one could cite.

The combination of research with training in the universities is the backbone of ultimate scientific progress in this country. To remain strong, financial freedom must be combined with intellectual freedom. Another



possible source of weakness is a dependence upon government for too large a proportion of financial support, and an emphasis upon applied research which will, in the words of Vannevar Bush (1945), "invariably drive(s) out pure . . . unless deliberate policies are set up to guard against this".

The danger is real. In 1952 only one dollar out of each five spent by the Federal Government in support of scientific activities at universities was for basic research. The other four dollars went for applied research and development. The muscle of research capacity in the universities must not be stretched too far, nor in the wrong direction.

### COMMUNICATION

Science without communication is like the links of a chain scattered loose upon the ground. There is no chain; the only strength is that of individual links.

Science is dynamic and builds constantly upon the past. "The past is prologue" in a very real sense, as witnessed by the hundreds of thousands of scientific papers that accumulate in journals and are abstracted, documented, referenced, collated, and translated. These are the stepping stones to the future, as well as a medium for communication of research results.

There are certain boundaries and barriers to communication, however—both natural and artificial. The sheer bulk of scientific information, which now requires the development of machine methods for its efficient use, is one of the most serious problems in communication. Another is the lack of a single international language for science. Important research is being done behind the Iron Curtain, for example, but we know all too little about it because of our lack of proficiency in the Slavic languages.

A barrier of constantly growing dimensions is the mounting volume of scientific and technical information subject to security restrictions. Is it possible that in our anxiety to safeguard legitimate secrets of military import, we have somehow thoroughly confused secrecy with security, until the thing that we seek to nurture is in some danger of being smothered in the process? Recently Mr. Lloyd V. Berkner, president of Associated Universities, Inc., which, as you know, administers the Brookhaven National Laboratory, called for a sober reappraisal of the effects of technological secrecy upon the progress of science. Mr. Berkner (1954) said:

Since more and more of our scientific activity is coming within the purview of secrecy, the need for appraisal of the effects of secrecy on our scientific stature and progress, and therefore on our national security, becomes of increasing importance. It seems highly probable that a little technological secrecy, like a little poison, may be a good thing, but too much can destroy us . . . As scientists, can we not demonstrate to the public how the benefits of science will quickly be extinguished by widespread technological secrecy? Can we not demonstrate that in suppressing

seemingly isolated scientific bits of information of direct military value, we at the same time prevent the germination of scientific ideas of much greater scientific, social, and military significance? Can we not show that such really great concepts, injected into our industrial complex, can provide far greater security through technological supremacy than we could ever hope to achieve through the secrecy of technological information?

Still other obstacles to the free flow of scientific information are the immigration and visa laws, which have the essential purpose of promoting our national welfare and security, but have simultaneously made it difficult or impossible for many scientists to communicate directly with one another.

Since communication is the life blood of science, the Foundation has supported research in documentation, in the translation of Russian scientific papers, and has advocated changes in the immigration laws that will safeguard our security while still permitting personal communication between scientists. We have also supported a program of assistance to American scientists traveling abroad for the purpose of attending international scientific meetings.

### CONCLUSION

In this brief enumeration of the principal sources of strength in science—that is, the individual scientist, his training and opportunities for research, and communication among scientists, I have tried to single out some of the possible weaknesses to which science is vulnerable in each of these categories. I have mentioned our failure to motivate students of high ability toward careers in science; the loss of potential scientists at various stages of career decision; the emphasis upon machines to the possible exclusion of simple experiments and observation; the danger to our universities in the imbalance between applied and basic research; and the overload on our communication system in science.

I should like to close with the reminder that the greatest weakness of all may be the possible loss of intellectual freedom as a result of the uncertainty and fear arising from our current activities with respect to security and loyalty. These problems confront the citizens of this country because of the temper of the times and the chaos in the world today. Nothing could be worse, however, than the isolation of scientists as a group and their subjection to special treatment simply because their ability, training and experience have made them increasingly important in national affairs. I should like to quote Dr. Bush again, this time from the article that appeared in the New York Times of June 13, 1954. Dr. Bush (1954) said:

Scientists need to be used not as lackeys or underlings but as partners in a great endeavor to preserve our freedoms. They need to be welcomed, so that they will respond in spite of the lure of peaceful pursuits, because they are inspired and heartened

as they join with their fellow men to preserve their way of life. They need, as do we all, words, and, far more important, acts and deeds to renew hope in troubled and loyal minds. They need to see, set up on a pedestal, fortified by the strongest bulwark in Executive acts, those principles which we would abandon at our peril.

This is another way of saying what Thomas Jefferson said over 150 years ago:

I have sworn upon the altar of God eternal hostility against every form of tyranny over the mind of man.

As the National Science Foundation grows in age and experience, so, too, we hope, will grow its contributions to our national strength in science. But no single agency or group of agencies, however wise and experienced, can meet the need in and of themselves. It must be the whole scientific community, and this means each individual member of the scientific community, who must bring about a better understanding of the nature of science and (if you will) of the peculiar nature of scientists. For it is only when people generally have acquired an understanding and application of those elements that make science strong, as well as those things that may weaken it, that we can feel that science in the United States is truly secure in an ultimate sense.

#### REFERENCES AND NOTES

- BEELO, FRANCIS. 1954. The Young Scientists. *Fortune*, June, p. 142.
- BERKNER, LLOYD V. 1954. The Impact of Nuclear Energy on Scientific Research. (Paper presented at the American Institute of Chemical Engineers, Ann Arbor, Michigan, June 24, 1954, as a part of the symposium, "The Social Impact of Atomic Energy").
- BUSH, VANNESVAR. 1945. Science the Endless Frontier, a Report to the President. *U. S. Government Printing Office*, Washington, D. C.
- , 1954. If We Alienate Our Scientists. *The New York Times Magazine*, June 15, 1954, p. 71.
- CHESTERTON, G. K. 1945. The Practical Cogitator. (Selected and arranged by Charles P. Curtis, Jr. and Ferris Greenslet) *Houghton Mifflin Co.*, Boston, p. 216.
- ROE, ANNE. 1953. The Making of a Scientist. *Dodd, Mead and Co.*, New York, p. 230.



# Physiological Aspects of Testing Contact Chemoreception. A Symposium <sup>1</sup>

## INTRODUCTION

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The processes of detecting chemical compounds by an animal, either at a distance or in contact with a special tissue of the animal's exterior, are ancient abilities. Simple animals without backbones relied upon their chemical senses for survival and propagation of the species long before the evolution of eyes and ears. Since man has gained a dynamic ascendancy over the animals, he has come to rely largely upon vision and hearing and his senses of smell and taste have been assigned a minor biological value by the older students.

As much of the enjoyment of life is derived from delectable foods and beverages, scents and perfumes, there is a very considerable production of commodities which impinge upon our chemical senses. Consequently, during the mid-twentieth century there has been a renaissance of scientific investigation as well as applied research in this department of sensory physiology. The motivation is as much a demand by consumers for better product-performance and more varied applications, as for pure scientific interest. In fact, it is not at all fantastic to prophesy that there will develop, during the next generation, an interest among people to sharpen their individual olfactory and gustatory senses by learning more about how to use them. Modern man has created many new flavors and odors, some of them serving the practical end of self-preservation, while others provide enjoyment.

The truth is, though, that we have only a limited understanding of the fundamental processes or mechanisms for reception of a stimulus by the chemoreceptors. This applies to the taste buds and their analogous organs in the simpler animals with which we are concerned in this symposium. Before the applied scientists and technologists of industry can create new savory substances, a precise knowledge of the activation of the taste buds is needed.

Whether this mechanism is physical, chemical, physicochemical, or biochemical in nature is a subject of much interest today. Some scientists hold that part of the answer has been elucidated, which is to say that the nature of the adequate stimulus has been determined to be ions of hydrogen and sodium. That the adequate stimulus, the least amount of

<sup>1</sup> This article together with the four with follow immediately were read at a Symposium of the Graduate Summer Session in Statistics at the Virginia Polytechnic Institute, June 25, 1954. James W. Johnston, Jr. presided at the Symposium.

\* Paper received August 31, 1954.

energy of a particular form necessary to discharge an electrical impulse by a taste-receptor, is not a simple, chemical entity is clear. On the other hand, the mechanism of "bitter" and "sweet" sensations is not clear. We are not certain, for instance, why two such chemically different compounds as cane sugar and saccharin give us a "sweet" sensation. Thus, a significant part of the elucidation of the mechanism of excitation lies ahead.

The theory of taste has a second aspect in the nature of the receptor cell, whose function it is to lower the threshold of the nerve fiber to some one form of energy. In the black blowfly (green bottle fly) a curved, blunt-tipped bristle is the contact chemo-receptor of one of the jointed mouth parts (labellum) and the front pair of legs (Grabowski and Dethier, 1954). The exterior surface is dry in contrast to the taste buds of mammals and man, which are exposed to saliva. In place of a stiff external bristle, our receptors are found in the taste buds on the tongue.

A dozen or more elongated receptor cells, some of which have minute hair-like processes at the outer end, occur in a taste bud. The "hairs" project through a pore into the mouth cavity. Direct stimulation may take place on them and the impulse pass through the receptor cell to a nerve fiber and thence to the brain. It has been estimated that there are about nine thousand of these microscopic buds in man (Moncrieff, 1951).

Unfortunately for a broad or comprehensive theory of gustation, the chemical nature of the mammalian receptor is not known. In all probability it is different from the insect receptor. Whether this difference has fundamental significance is a matter for conjecture. That is why good comparative experiments that will lend themselves to powerful statistical analyses are needed. A clear proof of a basic similarity or dissimilarity would advance importantly our understanding of contact chemoreception. The present status of the field will be presented in the essays which are to follow by discussions of the sapid molecules, the invertebrate animals, the mammals, and finally by an interesting account of how humans react when stimulated by certain foods.

#### LITERATURE CITED

- GRABOWSKI, C. T. AND DETHIER, V. G. 1954. The structure of the tarsal chemoreceptors of the blowfly, *Phormia regina* Meigen. *J. of Morph.*, 94: 1-17, 10 fig. and 2 tab.
- MONCRIEFF, R. W. 1951. The Chemical Senses. *Leonard Hall, Ltd.*, London.



## Physiological Aspects of Testing Contact Chemoreception. A Symposium

### MOLECULAR STRUCTURE AND TASTE STIMULATION<sup>1</sup>

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What is the chemical cause of taste? There are only four distinct kinds of taste — sweet, sour, salty, and bitter — so only a few variables seem involved, yet the question still ranks among the unsolved problems of science. The puzzle is made more mysterious by the recent observations that certain chemicals will prove tasteless to one fraction of a sampling audience, bitter to another fraction, and sweet to a third fraction — with surprisingly constant statistics! Only a few such substances are known (e.g., phenyl thiourea), but these singular discoveries prove that the taste response can be complicated by subjective differences of a hereditary nature.

Asymmetric molecules provide another important clue: a number of naturally occurring amino acids have a sweet taste, and can be described structurally as "left-handed" molecular forms; the corresponding "right-handed" amino acids, though mirror images and identical in every other respect, are tasteless! Thus the tasting mechanism also must involve some sort of hand-and-glove (or lock-and-key) matching contact between the tasting molecules and the tasted ones.

The most plausible theories of taste presume that the sensitive taste-bud surfaces are protein mosaics with repeating positive and negative electric charge patterns. These electric dipoles, or "taste couples," as R. B. Warfield<sup>2</sup> recently described them, are unbalanced by contact with a matching electric dipole in the tasting molecule, and this interaction "triggers" the nerve impulse.

Since the taste signal must be due to actual contact with these electrically active parts of the stimulating molecules, the puzzle reduces to a search for correlations with dipolar atomic groups. Eventual elucidation of the taste responses should be aided by the use of systematic structure descriptions, such as those given in the tables of this report.

R. W. Moncrieff<sup>3</sup> summarized "Taste and Constitution" with eight different theories of taste, and fifty-eight general relations between taste and chemical constitution. The complexity of the problem appears with the great variety of sweet and bitter substances, but even the relatively simple salty taste shows some significant variation with dilution.

*Salty* taste can be associated with simple ionic compounds of low molecular weight, and the characteristic taste of these metallic *salts* may be

<sup>1</sup> See footnote on page 14.

<sup>2</sup> R. B. Warfield, Abstracts of Papers, 125th Meeting of the American Chemical Society, September, 1954, page 15A.

<sup>3</sup> R. W. Moncrieff, "The Chemical Senses," Wiley, New York, 1946, pages 273-278.

\* Paper received September 30, 1954.

due to their high degree of hydration: similar ionic compounds of heavier molecular weight generally taste bitter. *Sour* taste is due to the hydrogen ion of simple acid structures.

Clues to the ultimate solution of the total tasting mechanism may be found in dualistic tables of chemical structures that compare sweet-tasting substances with nonsweet ones, among the simplest classes of chemicals. The four simplest classes of such structures are, in elementary terms, (1) the open-chain or aliphatic compounds of carbon, hydrogen, and oxygen; (2) the aliphatic nitrogen derivatives; (3) the aliphatic sulfur derivatives; and (4) the aliphatic halogen derivatives. The several hundred sweet and nonsweet aliphatic compounds mentioned in Moncrieff's treatise have been described with systematic structural symbols and listed in the illustrated tables according to these four elementary classes. The nitrogen derivatives form such a large group that they have been subdivided into two tables.

*Oxygen* derivatives of the open-chain hydrocarbons contain two characteristic dipole groups in addition to the lone "etheric" oxygen segments: the hydroxyl or — OH group (here denoted by the letter Q), and the carbonyl or — CO. — connective (here denoted by the letter V). The less active hydrocarbon chains are identified distinctively by arabic numerals which show the *number of carbon atoms* in the represented alkyl group. Ternary carbon atoms are denoted by the letter Y (suggestive of the bond pattern), and quaternary carbon atoms by the letter X; prime marks on X or Y denote methyl groups (following a contraction suggested by W. Gruber). A fully detailed account of the general notation is given elsewhere.<sup>4</sup>

Table I shows that the sweet-tasting oxy-derivatives generally contain hydroxyl groups (Q) while the sour-tasting derivatives contain carboxylic acid groups (QV). However, this table includes a sufficient number of exceptions, even with this small number of structural variables, to hint at the subtlety of the tasting mechanism.

Nitrogenous structure descriptions introduce four new atomic group symbols in addition to the letter N for lone nitrogen atoms: W for the two oxygen atoms in the nitro or NO<sub>2</sub> group, K for the quaternary and cationic nitrogen atom, M for the imino or mid-amino NH group, and Z for the terminal ("hydrazino") amino group, NH<sub>2</sub>.

Table II compares the sweet and nonsweet substances that contain lone or quaternary nitrogen atoms (N or K, respectively); table III compares those that contain the hydrogenated imino or secondary amino and primary amino groups (M and Z, respectively). Here again the structural variations given abundant evidence for the subtlety of the relation between taste and constitution. For example, some nitro compounds are bitter, though most of the listed ones are sweet; the long-chain acid betaines are bitter, but betaine and homobetaine are sweet; carbylamines are bitter, but the isomeric nitriles are sweet. (In these structural generalizations, the nonspecific or generic letter A denotes any alkyl group)

<sup>4</sup> W. J. Wiswesser, "A Line-Formula Chemical Notation," Crowell, New York, 1954.

Table IV includes corresponding examples of the aliphatic sulfur compounds cited by Moncrieff; most of these are bitter-tasting substances. The prevailing "bitterness" of the lone sulfur atom is in striking contrast with the intense sweetness of saccharin and related structures that contain a cyclic sulfonyl or  $\text{---SO}_2\text{---}$  group.

Table V compares the sweet and nonsweet aliphatic halogen compounds. In this table, chlorine atoms are denoted by the letter G (which avoids the typewriting ambiguity of Cl) and bromine atoms, by the letter E.

Moncrieff's treatise contains many additional examples of benzenoid and other cyclic structures, which have been listed in similar dualistic tables of structure descriptions. These tables have not been included in this paper since they offer no striking clues in the problem of correlating structure with taste; the author will gladly furnish copies of these additional tables to those who wish to explore this challenging biochemical puzzle.

The reader who searches for structural correlations in these or similar tables might rediscover some of the fifty-eight general relations cited by Moncrieff, and he might account for the facts with fewer than eight theories, but he is forced to a minimum conclusion that there is no simple structural characteristic that causes sweetness or bitterness. The ultimate explanation must come with more subtle physical details, such as the fractional electric charge distributions among these atomic groups, or the angular relations among these charges that are possible in each surface-slithering molecule.

TABLE 1.—ALIPHATIC OXYGEN COMPOUNDS

NONSWEET SUBSTANCES		SWEET-TASTING SUBSTANCES	
Notation	Name Identification	Notation	Name Identification
IV1	Acetone	1OVYQYQVO1	Dimethyl tartrate
1VO6OV1	* Hexamethylene glycoldiacetate	1Y'1VO1	Methyl isovalerate
2OV4VO2	* Diethyl adipate	3VO2	Ethyl butyrate
6V1	Methyl hexyl ketone	3VO3	Propyl butyrate
8OVIY''	Octyl isovalerate	Q1X1Q1Q1Q	Pentaerythritol
O:1	Formaldehyde	Q1YQ1Q	Glycerol
O:2	Acetaldehyde	Q1YQ, 1:O	D-Glyceraldehyde
O:2:Y'3:Y''	Citral	Q1YQ/1:O	L-Glyceraldehyde
O:2Y'3:Y''	Citronella	Q1YQYQ2:1	Hexenyl glycerin
Q1:O	Formic acid (sour)	Q1YQYQYQYQ1:O	Aldohexoses (Glucose, mannose, etc.)
Q2O1	Glycol methyl ether	Q1YQYQYQYQ1Q	Hexitols (Sorbitol, mannitol, etc.)
Q4	Butyl alcohol	Q2	Ethyl alcohol
Q6Q	* Hexamethylene glycol	Q2Q	Ethylene glycol
QV1	Acetic acid (sour)	Q3Q	Trimethylene glycol
QV2VQ	Succinic acid (sour)	Q4Q	Tetramethylene glycol
QV3	Butyric acid (sour)	Q8	Octyl alcohol
QVVQ	Oxalic acid (sour)	QY'1Q	Propylene glycol
QVY':1VQ	Citraconic a. (sour)		

\* Bitter.



TABLE I. ALIPHATIC OXYGEN COMPOUNDS (Continued)

NONSWEET SUBSTANCES			SWEET-TASTING SUBSTANCES		
NOTATION	NAME	IDENTIFICATION	NOTATION	NAME	IDENTIFICATION
QVYQ1VQ	Malic acid	(sour)	QY':6		2-Octen-2-ol
QVYQYQVQ	Tartaric acid	(sour)	QY3.Y':2		3-Me-2-Hepten-4-ol
QY'6	*Methyl heptyl carbinol		QY5.1:1		1-Octen-3-ol
QY'VQ	Lactic acid	(sour)			

TABLE 2.—ALIPHATIC NITROGEN (N, K) DERIVATIVES

BITTER SUBSTANCES			SWEET-TASTING SUBSTANCES		
Notation	Name	Identification	Notation	Name	Identification
1K°, -Q	Tetramethylammonium	hydroxide	NCA		Nitriles (Cyanides)
AKA, A.A., -Q	Quaternary bases		NNNA		Azides
ANA.A	Tertiary amines		ONO2		Ethyl nitrite
ANA.VNA.A	Tetra-alkyl ureas		OV1K*		Betaine
CN1	Methyl carbylamine		OVY'K*		α-Homobetaine
CN2	Ethyl carbylamine		QN:A		Oximes (Aldo- or keto-)
ONO2:1	Allyl nitrite		QN:Y1Q1Q		Di-HO-acetone oxime
OV14K*	ω-Aminopentadecylic acid betaine		QV1ON:A		Oxim-acetic acids
OVY2.K*	Trimethyl α-aminobutyric acid betaine		WN2		Nitroethane
WN2:1	Nitroallyl		WN5		Nitropentane
WNX'2.2	tert-Nitrohexane		WNO1Y''		Isobutyl nitrate
			WNO4		Butyl nitrate
			WNY'NW		Dinitroethane (1, 1-)
			WNY2.NW		Dinitropropane (1,1-)

TABLE 4.—ALIPHATIC SULFUR DERIVATIVES

BITTER SUBSTANCES			SWEET-TASTING SUBSTANCES		
Notation	Name	Identification	Notation	Name	Identification
ASA	Thioethers		S:YS1.O2		Methyl xanthate
ASSA	Dialkyl disulfides		S:YSA.O2		Alkyl xanthates
SH2M1	β-Methylaminoethyl mercaptan				
SHA	Mercaptans				
SHVA	Thioamides				
S:YZMA	Thioureas				
WS2.X''SW2	Sulfonal				
WSA.OA	Alkylsulfonic esters				

\* Bitter.

TABLE 3.—ALIPHATIC NH AND NH<sub>2</sub> DERIVATIVES

NONSWEET SUBSTANCES		SWEET-TASTING SUBSTANCES	
<i>Notation</i>	<i>Name Identification</i>	<i>Notation</i>	<i>Name Identification</i>
IMVM1	* <i>sym</i> -Dimethyl urea	IVMMVMM1	Diacetyl
IVMV1	*Diacetamide		carbohydrazide
Z1	*Methyl amine	O:1M1	Methyl formamide
Z14VO1	*Methyl	QV1M1	Sarcosine
	$\omega$ -aminopentadecylate	QV3M1	$\gamma$ -Methylaminobutyric acid
Z14VQ	$\omega$ -Aminopentadecylic acid	Z1VQ	Glycine
Z16VO1	Methyl	Z2VQ	B-Alanine
	$\omega$ -aminopentadecylate	ZMVYVMZ	Me Malonic dihydrazide
Z16VQ	$\omega$ -Aminoheptadecylic acid	ZMVY2.VMZ	Et Malonic dihydrazide
Z1:O	*Formamide	ZMVY3.VMZ	Pr Malonic dihydrazide
Z7	*Heptyl amine		Succinic dihydrazide
ZMVY4.VMZ	*Bu Malonic dihydrazide	ZMV2VMZ	5-Methyl semi-oxamazide
ZMV2VMN:2	*Acetaldehyde succinic dihydrazide	ZMVVM1	Alkyl malonic hydrazides
ZMVVQ	Oxalic hydrazide	ZMVYQ1VMZ	Malic dihydrazide
ZMVYMZVMZ	Malonic trihydrazide	ZMVYQYQVMZ	Tartaric dihydrazide
ZV1	*Acetamide	ZV1VMA	Alkyl malonamide
ZV1Q	*Glycollic acid amide	ZV3	Butyramide
ZV2	*Propionamide	ZVN1.1	<i>as</i> -Dimethyl urea
ZV1VZ	Malonamide	ZVN2.2	<i>as</i> -Diethyl urea
ZV4VZ	Adipamide	ZVVMZ	Semi-oxamazide
ZVM4O2	* $\partial$ -Ethoxybutyl urea	ZX"1VQ	$\beta$ -Aminoisovaleric acid
ZNVVZVZ	Triacetamide	ZX"VQ	$\alpha$ -Aminoisobutyric acid
ZVO2	*Urethane	ZYVQ	Alanine (D- or L-)
ZVVZ	Oxamide	ZYVQ/1VZ	L-Asparagine
ZVZ	*Urea	ZYVQ/1Y"	L-Leucine
ZYVQ,1V2	D-Asparagine	ZYVQ/2	L-Aminobutyric acid
ZYVQ,1Y"	D-Leucine	ZYVQ/3	L-Norvaline
ZYVQ,Y"	D-Valine	ZYVQ/4	L-Norleucine
ZYVQ,Y2	*D-Isoleucine	ZYVQ/Y"	L-Valine
ZVYNW.CN	Nitrocyacetamide (sour)		

\* Bitter.



TABLE 5.—ALIPHATIC HALOGEN DERIVATIVES

NONSWEET SUBSTANCES		SWEET-TASTING SUBSTANCES	
<i>Notation</i>	<i>Name Identification</i>	<i>Notation</i>	<i>Name Identification</i>
E2:1E	1,3-Dibromopropylene	E1YE:1	2,3-Dibromopropylene
G2OV3	*Chloroethyl butyrate	G1	Methyl chloride
GY3.Y'G	*2,3-Dichlorohexane	G1Y''	Isobutyl chloride
GYG1O1YGG	*s-Tetrachloroethyl ether	G2	Ethyl chloride
O:1XGGG	*Chloral	GA	Alkyl chlorides
QV1G	Chloracetic acid (sour)	GY''	Isopropyl chloride
QYQXGGG	*Chloral hydrate	GYGG	Chloroform
WN2G	1-Chloro-2-nitroethane	GYGXGGG	Pentachloroethane
WNY'G	1-Chloro-1-nitroethane	GYGYG1G	1,1,2,3-Tetrachloropropane
Z1X'SW2.SW2/GH	Aminosulfonal MC1	GYGYGG	s-Tetrachlorethane
ZHH,.E	*Ammonium bromide	ZVXEEE	Tribromacetamide
ZHH,.G	**Ammonium chloride	ZVX'GVZ	Me Chloromalونamide
ZHH,.I	*Ammonium iodide	ZVXG2.VZ	Et Chloromalونamide
ZV1G	Chloroacetamide	ZVXGG.VZ	Hx Chloromalونamide
ZV1I	Iodoacetamide	ZVXGGG	Trichloroacetamide
ZVXGVZ2Y''	* Isoamyl Chloromalونamide	ZVYEE	Dibromacetamide
ZVXGVZY''	* Isopropyl Chloromalونamide	ZVYGG	Dichloroacetamide

\* Bitter.

\*\* Salty Bitter.

## Physiological Aspects of Testing Contact Chemoreception. A Symposium

### THE COMPARATIVE PHYSIOLOGICAL APPROACH TO THE STUDY OF CHEMORECEPTION<sup>1</sup>

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The comparative physiologist attempts to contribute to any field of biological investigation in at least two ways. First, by studying a physiological process in many different animals, he tries to determine what is essential to the process, and what may be a peculiarity typical of one particular experimental animal. Secondly, by selecting animals which lend themselves to particular experimental techniques, he tries to shed some light on aspects of the problem which otherwise could not be studied. It is primarily the latter type of approach which will be discussed here.

As has been indicated elsewhere in this symposium, the accessibility of invertebrate chemoreceptors and the lack of an overlying mucous layer in many forms constitute the major reasons for studying invertebrate animals when attempting to obtain fundamental knowledge of chemoreception. Another advantage of invertebrates is that relatively large homogeneous populations of experimental animals can often be obtained. Small size and short life cycles permit rearing of thousands of individual animals under almost identical conditions. This, of course, makes it easier to characterize the responses of the population in a meaningful statistical way, and hence the individual variations in thresholds or reactions, which have to be expected in all biological material, are not apt to be misleading.

It is not within the scope of this paper to attempt an exhaustive review of the contributions from comparative physiology to the understanding of chemoreception. As an example, one question of fundamental importance in this field will be treated through an analysis of pertinent experiments, giving particular attention to the statistical methods used. The question is usually stated somewhat as follows: What are the essential properties of a chemical compound that cause it to have its effect on a receptor cell? Certain generalizations, in partial answer to this question, have become widely accepted among comparative physiologists, and the evidence on which these generalizations rest may be analyzed as representative of the comparative physiologist's approach.

In theory, the chemoreceptors of a large homogeneous population of animals are exposed to known concentrations of various chemical stimuli.

<sup>1</sup> See footnote on page 14.

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An arbitrary measure of response by the population is regarded as "threshold". Comparisons of the thresholds of responses toward different chemical stimuli enables the investigator to rank the chemical stimuli in their order of relative stimulating effectiveness. Then any property of the chemicals which is present to a larger degree among highly stimulating compounds than among relatively ineffective compounds is examined as a possible clue to the essential properties of a stimulus. If, in a large series of compounds, a good correlation is found between such a property and the stimulating capacity of the compounds, the property is considered a likely prospect for being included among the essential ones, and its occurrence among a new series of chemicals is used for predicting their relative order of effectiveness. If the predictive value of the tentative new concept is found to be high, the whole process is repeated using other types of experimental animals. Only if similar results are then obtained can the new idea regarding the nature of the essential stimulating property be accepted as having any general biological significance. It will be obvious that some kind of statistical analysis must enter into this process at many points. A more specific analysis should make clear the particular statistical methods which have been found to be generally useful.

Suppose that the experimenter is impressed with the number of cases in which inorganic salts are known to stimulate chemoreceptors. It is well known that these salts differ widely in their capacity to stimulate chemoreceptors. The problem is to find out what properties of these salts determine their stimulatory power. An animal is chosen in which the salts stimulate the same small group of receptors. An apparatus is devised for administering known quantities of stimulant and permitting easy study of the reaction of the animals. (There is good evidence that the reaction of the whole animal can be used as a reliable measure of the stimulation of chemoreceptors in many invertebrate animals.) With each one of the salts to be tested, a series of doubling concentrations is prepared and used in the experiment. (The difference between concentrations tested is kept large so that differences in powers of discrimination by members of the test population will not influence results.) The population is exposed to the various prepared concentrations of each salt, and responses noted. In tests of various salts the results show certain statistical resemblances: when the percentage of animals responding to a salt is plotted against the concentration of the salt administered, an asymmetric sigmoid curve is obtained. Statistically, this is exactly the same result as obtained in tests of the effect of toxic agents on multicellular animals (Bliss, 1950), and it appears to be a general phenomenon in studies on chemoreception, regardless of the type of chemical tested.

The sigmoid dosage-response curve is often rather unwieldy for purposes of later analysis. By expressing the concentration of stimulus as the logarithm of the molar concentration used, and by converting the percentage responses into deviates of the normal curve, or probits, a linear relationship is obtained between the concentration of stimulus administered and the response obtained. The concentration to which fifty per cent of the population responds is customarily chosen as "threshold"



for any stimulus. The theory of probit analysis is given in the book by Finney (1952) and the precise statistical method most generally useful in these studies is presented in detail by Bliss (1938); a shorter procedure, yielding results essentially the same, has been provided by Miller and Tainter (1944).

A short digression here is necessary to emphasize the utility of this method of analysis and its significance. Dethier and Chadwick (1948) have demonstrated that the linear relationship between stimulus and response, when each is expressed as specified above, is obtained with a variety of insects and is true also of those vertebrates for which adequate data have been presented. As an experimental tool, this method is extremely useful, since it permits extrapolation of data to threshold when solubility characteristics or expense of a chemical do not permit tests throughout the entire range of effective concentrations.

To return to the salts, which provide a convenient example, let us suppose that two series are tested: one of sodium salts, and one of chlorides. These groups might include the following:

<i>Sodium salts</i>	<i>Chlorides</i>
Na I	KCl
Na Br	Na Cl
Na acetate	Li Cl

It will be noted that there is one component of every compound that is shared with other members of its own series. Therefore, the property which is actually being compared in a study of the relative effectiveness of chemicals in each group depends upon the unlike parts of the compounds. The sodium group tests the relative stimulating effectiveness of the I<sup>-</sup>, Br<sup>-</sup>, and CH<sub>3</sub>COO<sup>-</sup> components, while the chloride series tests the relative stimulating effectiveness of K<sup>+</sup>, Na<sup>+</sup>, and Li<sup>+</sup>. When this experiment was actually performed, the orders of effectiveness were found to be that given in the listings above. What makes I<sup>-</sup> stimulate in lower concentrations than Br<sup>-</sup>, and Br<sup>-</sup> in lower concentrations than CH<sub>3</sub>COO<sup>-</sup>? These differences are statistically significant as can be shown by the usual statistical methods. Actually, an adequate explanation has never been given for this series. This, plus other information, has suggested that anions may not be very important influences on the stimulatory powers of compounds, although some unexpected principle may yet be uncovered from these data.

An interesting explanation has been found for the cation series. The relative stimulating effectiveness of these and other cations can be related to their ionic mobilities. In fact, a plot of ionic mobility against threshold concentrations shows a linear relationship. Other properties of the cations which have been tested in this manner show no such relationship to thresholds. Data of this type have been obtained from studies on insects from quite different sorts of environments by Frings (1946) and Hodgson (1951). The correlation of stimulating effectiveness with ionic mobilities

of cations suggests that the limiting factor in chemoreception is some kind of "access to the receptor system". It is not known whether the stimulus merely reaches a receptor cell membrane and is temporarily adsorbed there, or whether in order to be effective the stimulating chemical must penetrate into the receptor cell itself.

In order to determine whether some kind of penetration property also determines the stimulating effectiveness of other compounds as well, the organic alcohols might be tested. If the sensitivity to alcohols differing in length of the main carbon chain is tested with an appropriate insect or other arthropod, the results appear quite startling at first. Large quantities of methyl, ethyl, and propyl alcohols are necessary to evoke threshold reactions. Relatively minute amounts of butyl, amyl, and hexyl alcohols are required. If one prepares a plot of threshold concentrations against number of carbon atoms, it can be seen that a sharp and significant break in the curve appears between propyl and butyl alcohols. What property of the alcohols also shows this peculiar irregularity in distribution? After testing various possibilities, it has been shown that oil-water partition coefficients increase sharply in the longer chain alcohols in precisely the manner observed with the alcohol thresholds. Since the receptor cell membrane presumably contains a high proportion of lipoids, these data also are interpreted as evidence that penetration to the site of action is the limiting factor in chemoreception. This has been demonstrated for insects from various environments (Dethier and Chadwick, 1948; Hodgson, 1951), and for various other arthropods.

What bearing do these findings have on human "taste" reception? Comparisons of the invertebrate data with those obtained from human tests are not very extensive because human subjects cannot be safely exposed to many of the chemicals tested on invertebrates. However, the comparisons thus far available indicate that the factors limiting the effectiveness of stimulation of chemoreceptors in man and invertebrates are the same. The most extensive comparison of the physiology of human receptors with those of invertebrates has been made by Dethier (1951), using homologous aliphatic glycols as test substances. When stimulating either the chemoreceptors of the human tongue or the tarsal chemoreceptors of the blowfly, threshold concentrations of glycols decrease logarithmically as the carbon chain is lengthened. It is encouraging to know that in a field beset with many impediments to experimentation, results obtained on the more easily handled experimental animals may have general significance for other organisms as well.

To summarize, the insects and other invertebrates are excellent experimental material for the study of chemoreception because of (1) accessible, localized receptors without overlying coatings, and (2) the availability of large numbers of animals, permitting rigorous statistical characterization of the sensitivity of a population of animals. The method of testing the stimulating capacity of chemicals and the probit-analysis treatment of the data have been discussed. The generalizations which can be formulated in harmony with these results are believed to be of general significance for understanding chemoreception in other organisms, including man.



## LITERATURE CITED

- BLISS, C. I. 1938. The Determination of the Dosage-mortality Curve from Small Numbers. *Quart. Jour. Pharm. and Pharmacol.*, 11: 192-216, 3 fig., 9 tab.
- , 1950. The Design of Biological Assays. *Ann. N. Y. Acad. Sci.*, 52: 877-888.
- DETHIER, V. G. 1951. Taste Sensitivity to Compounds of Homologous Series. *Amer. J. Physiol.*, 165: 247-250, 2 fig.
- DETHIER, V. G. AND L. E. CHADWICK. 1948. Chemoreception in Insects. *Physiol. Rev.*, 28: 220-254, 2 tab.
- FINNEY, D. J. 1952. Probit Analysis, 2nd Ed. *Cambridge University Press*.
- FRINGS, H. 1946. Gustatory Thresholds for Sucrose and Electrolytes for the Cockroach, *Periplaneta americana* (Linn.). *J. Exp. Zool.*, 102: 23-50, 6 fig., 4 tab.
- HODGSON, E. S. 1951. Reaction Thresholds of an Aquatic Beetle, *Laccophilus maculosus*, to Salts and Alcohols. *Physiol. Zool.*, 24: 131-140, 4 fig., 2 tab.
- MILLER, L. C. AND M. L. TAINTER. 1944. Estimation of the  $ED_{50}$  and its Error by Means of Logarithmic-Probit Graph Paper. *Proc. Soc. Exp. Biol. and Med.*, 57: 261-264, 1 fig.

## Physiological Aspects of Testing Contact Chemoreception. A Symposium

### CONCEPTS OF CONTACT CHEMORECEPTION IN MAMMALS AND MAN<sup>1</sup>

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The fact that chemical sense organs are grouped together at the entrance to the respiratory and alimentary tracts of mammals and man means that these senses are frequently stimulated in combination. The contribution of each of these senses to the complex experience we call flavor or "taste" of food may be ascertained only by analytical study. These perceptions are further complicated by other components such as warmth, cold, touch, and pressure. In man, the order of decreasing sensitivity of the chemical sensory organ is smell, taste, and common chemical sense. In general or comparative use though, these terms should connote chemoreceptors of particular sensitivities rather than particular sensations. Thus, Parker and Stabler (1913) showed that for man grain alcohol had an olfactory threshold of 0.000125 molar solution, a gustatory threshold of 3.0 molar solution, and a common chemical sense threshold of 5.0-10.0 molar solution.

We may then, for purposes of discussion, follow Dethier and Chadwick's (1948) suggestion that contact chemoreceptors are stimulated by substances in solution; e.g., the taste buds and simple end-organs of the general chemical sense. The latter receptors may be disposed of by recalling that above a certain concentration grain alcohol is irritating or painful to the soft lining membranes of mouth and throat, whereas just below this concentration it is tolerated, and is enjoyed by many at milder concentrations. The evidence for this primitive modality of sensation is perhaps best exemplified by the reaction of insects. For them most substances are optimally attractive at a particular concentration and decrease progressively as the concentration increases (the attraction changing to repellency).

Since investigators of the fundamentals of chemoreception have long felt that precise determinations of threshold values, statistical concepts in themselves, would contribute to an understanding of the nature of the adequate stimulus, much of this work has been done on taste. For instance, man is sensitive (Pfaffmann, 1951) to the extremely bitter compound, quinine hydrochloride, at the approximate minimum concentration of  $1.5 \times 10^{-7}$  molar solution; he is sensitive to the sour compound, hydro-

<sup>1</sup> See footnote on page 14.

\* Paper received August 31, 1954.

chloric acid, at  $1.25 \times 10^{-3}$  molar solution; he is sensitive to the salty compound, sodium chloride, at  $9 \times 10^{-3}$  molar solution; and he is sensitive to sweet cane sugar, sucrose, at  $2 \times 10^{-2}$  molar solution.

Consequently, it will aid us to consider the meaning of these classes of sapid compounds and the degree of refinement of experimental and statistical controls achieved or deemed adequate for theorizing about gustatory function and its applications. While the taste buds in the tongues of man, rat and cat contain receptors that look alike in microscopic preparations, experimental methods which we may term *punctiform* and *direct* have demonstrated physiological types. Punctiform exploration of the human can be done simply by applying a pure solution with a tiny camel's hair brush to many discrete sites on the tongue. The result of many tests with many pure solutions is a map comprised of four areas that are of the lowest threshold for bitter, sour, salty and sweet sensations. These, then, are the total number of submodalities of taste which are more or less localized in different regions of the tongue, differing in position by as much as several centimeters. This arrangement permits an opportunity for experimentation which has been only partially exploited. Since there is considerable overlapping, we should think of the regions as quantitatively delineated. The receptors for sweet and salt are near the tip, those for sour are on the back lateral surfaces, whilst those for bitter are towards the back upper surface. A more controlled method of stimulation, however, is by means of an insulated burette arrangement from which a fine stream of the test solution is directed on the tongue, thus keeping the mechanical stimulation of the different solutions constant (Zotterman, 1949).

Richter (1943) discussed a preference or choice technique for threshold determination, devised by Richter and Clisby (1941), that is essentially the same for rats and humans, except the latter subjects gave oral descriptions of their taste reactions. The design utilized three of the submodalities of taste. The subjects were permitted to sip or drink liquids, the rats from a pair of bottles and the humans from a pair of 2-ounce glasses. The rats were caged separately and the humans faced the experimenter across a table one at a time. One unknown liquid was distilled water, the other was a pure solution of sodium chloride, cane sugar, or phenylthiocarbamide (phenylthiourea) — a very bitter tasting substance which has a highly toxic effect on rats, 1 to 2 milligrams being sufficient to kill them in only a few hours. The stimulus was first presented in so low a concentration to the rats as to make it indistinguishable from distilled water, and on successive days the concentration was increased in small steps. Of the 23 male and 24 female rats tested, all of them eventually accepted or rejected (drank less of) a concentration of the solutions. This level was below the lethal dose for the poison. This acceptance or rejection value was taken as the taste threshold as it was an indication of recognition of difference between the solutions and distilled water. Of the 139 male and 122 female humans tested, when a subject definitely stated that one glass had a bitter, salty or sweet taste the test was discontinued. If the subject could not taste a 0.25 per cent solution of phenyl-



thiocarbamide, he was regarded as "taste-blind". Many concentrations were presented to the humans in one day.

For sodium chloride rats had a threshold of 0.055 gram per cent and humans had one of 0.087 per cent, but noticed a difference at 0.016 per cent. For sucrose rats exhibited a preference at 0.5 per cent and humans recognized "sweet" taste at 0.41 per cent, but noticed a difference at 0.17 per cent. For phenylthiocarbamide rats had a mean rejection value of 0.0003 per cent with a range of 0.00005 to 0.02 per cent. Humans had the same mean threshold for this substance with a range of 0.00001 to 0.2 per cent. Thus, an astonishingly close relationship between rats and humans was found, having virtually the same thresholds with the difference that humans showed a wider range of individual variation. Richter carried these experiments much farther by providing rats with all the raw materials of a healthful diet and demonstrating that an innate specific appetite, functioning in part through the taste buds, provided self-regulation of the steady, physiological state (good health).

The problem of determining the absolute taste thresholds was not solved by the preference method. Patton and Ruch (1944) stated that the failure of normal rats to select salt solutions weaker than 0.055 per cent does not necessarily mean that the salt cannot be detected, but rather that the motivation is insufficient to force the animal to make such difficult discriminations. Due to the interest engendered by the knowledge that humans exhibit great differences between individuals for sensitivity to phenylthiourea (phenylthiocarbamide), Harris and Kalmus (1949) devised a method for determination of the absolute threshold. One of the difficulties that arises out of presenting subjects with increasing concentrations of phenylthiourea and recording their responses is that people differ in the degree of sensation which they consider to be a positive taste. A further difficulty is that different subjects, particularly near their threshold, record very different sensations; for example, besides bitter they may refer to the taste as sweet, sour, salty, astringent, like flat water and so on. These difficulties were surmounted by determining the lowest concentration of the substance which a subject can discriminate from water. The experimental design is based on the classical tea experiment of R. A. Fisher.

A stock solution containing 0.13 per cent phenylthiourea is made up in boiled tap water and serial dilutions are made up from 1300 milligrams per liter to 0.16 milligrams per liter in fourteen steps.

(1) Starting from the higher dilutions and working down, the subject is given a few cc. in a tumbler till he first says that he perceives a definite taste.

(2) Then eight tumblers are presented, four of which contain a few cc. of water and four contain the solution determined in stage one. The glasses are arranged at random. The subject is told that four contain water and four the substance. If the two groups are correctly separated the test is repeated with the next lower concentration and so on, until the subject can no longer discriminate correctly. The lowest concentration at which a completely correct answer is given is taken as the threshold. If the initial separation is not entirely correct, the process is repeated in

reverse by presenting increasing concentrations until the correct answer is given.

Harris and Kalmus found that consistent results were produced and that in 441 boys and men taste sensitivity decreased with increasing age. This was true for both tasters and non tasters. Among the tasters, the 10-19 year olds had a mean threshold of 2.54 milligrams per liter of water; the 20-49 year olds had between 2.54 and 5.08 milligrams per liter; and the 50+ year olds had 10.16 milligrams per liter. Thresholds for the respective age classes of non-tasters were 6 to 7 serial dilutions more concentrated. Verification of earlier work showed that women had a slightly greater taste sensitivity for phenylthiourea than men.

The direct method of typing the taste receptors and determining thresholds was utilized by Pfaffmann (1941) in the cat. He attached electrodes to the appropriate gustatory nerve conducting impulses from the taste buds and recorded electrical impulses by means of a Matthews oscillograph. The apparatus gives a photographic record. Since these were single fiber recordings of the magnitude and frequency of impulses arising immediately after stimulation of the tongue by pure solutions with a small brush, some doubt is cast on the discrete nature of the taste receptors. No doubt about the fact of stimulation by a given solution of known concentration can be entertained. Pfaffmann found that the cat has three types of fibers in its taste-nerve: (a) responds to acid only, (b) responds to acid and sodium chloride, and (c) responds to acid and quinine. No fibers responding to sugar were found, but a map or zonal distribution of (a), (b), and (c) was delineated. A salt-quinine fiber was not found. Of much interest is that acid was an effective stimulus of all types of gustatory endings, while salt and quinine sensitivity do not exist independently, but always in conjunction with the hydrogen ions.

The theory supported by this direct evidence from a series of cats is that sodium chloride and quinine each stimulate a different group of receptors. Discrimination between these two substances presumably depends on the fact that impulses reach the central nervous system in two different sets of fibers. Since hydrogen ions, by dissociation of the acid, activate all receptors, sour must be discriminated from sodium chloride because acid produces simultaneous activity in all fibers as opposed to activity in one fiber group. If we carry over this mechanism *to the human*, we might say that a discharge of impulses in one set of fibers will produce salt, whereas discharges in the *same* fibers combined with activity in all the remaining gustatory fibers will produce sour. In such a system, sensory quality does not depend simply on the "all or nothing" activation of some particular fiber group alone, but on the pattern of other fibers which are active.

Since Richter thought that lowered salt concentration of the blood caused by removal of the adrenal glands would lower the threshold for salt, Pfaffmann and Bare (1949) showed by the direct method (or method of choice in studying the physiology of chemoreception) that the average threshold for salt was the same for normal rats and adrenalectomized subjects. This result suggests that salt needy rats display a preference as



soon as they can taste salt, rather than Richter's tentative suggestion that threshold is somehow determined by the blood concentration of sodium chloride.

However, Richter's postulate that taste has a primary biological value is supported by Davis' (1939) findings on fifteen human infants of weaning age. When presented with all the natural foods necessary for maintenance of the body, these inexperienced infants, by self-selection, chose fifteen different diets that sustained good health for four years, this being the longest period Davis experimented. She concluded that selective appetite is, primarily, the desire for foods that please by smelling or tasting good. In a few days, these infants developed patterns of selective appetite on the basis of sensory experience and a feeling of comfort and well-being following eating.

On the complicated and elusive topic of the mechanism of taste receptor activation much has been written, but an adequate consideration of it must be sought through investigation of cellular changes in the sensory end-organ itself, a difficult and challenging problem. We know that stimulation requires the contact of the solution with the receptor — just what happens next is not known. One looks to the newer applications of creative statistics as well as to more refined apparatus and ingenious skills for needed guidance or tools.

#### LITERATURE CITED

- DAVIS, C. M. 1939. Results of the Self-Selection of Diets by Young Children. *Canad. Med. Assn. J.*, 41: 257-261.
- DETHIER, V. G. AND L. E. CHADWICK. 1948. Chemoreception in Insects. *Physiol. Rev.*, 28: 220-254, 2 tab.
- HARRIS, H. AND H. KALMUS. 1949. The Measurement of Taste Sensitivity to Phenylthiourea (Pt. I). *Annals of Eugenics* (London), 15: 24-31, 5 fig., 5 tab.
- PARKER, G. H. AND E. M. STABLER. 1913. On Certain Distinctions between Taste and Smell. *Am. J. Physiol.*, 32: 230-240.
- PATTON, H. D. AND T. C. RUCK. 1944. Preference Threshold for Quinine Hydrochloride in Chimpanzee, Monkey and Rat. *J. Comp. Psychol.*, 37: 35-49, 3 fig., 2 tab.
- PFAFFMANN, C. 1941. Gustatory Afferent Impulses. *J. Cell. and Comp. Physiol.*, 17: 243-258, 11 fig.
- . 1951. Chapter 29, Handbook of Exp. Psychol. (S. S. Stevens, ed.) *John Wiley and Sons, Inc.*
- PFAFFMANN, C. AND J. K. BARE. 1949. Gustatory Thresholds in Normal and Adrenalectomized Rats. *J. Comp. and Physiol. Psychol.*, 43: 320-324, 2 fig., 1 tab.
- RICHTER, C. P. 1942-1943. Total Self-Regulatory Functions in Animals and Human Beings. *Harvey Lectures, Series 38*: 63-103. New York, N. Y. 19 fig., 1 tab.



- RICHTER, C. P. AND K. H. CLISBY. 1941. Phenylthiocarbamide Taste Thresholds of Rats and Human Beings. *Amer. J. Physiol.*, 134: 157-164. 2 fig., 3 tab.
- ZOTTERMAN, Y. 1949. The Response of the Frog's Taste Fibers to the Application of Pure Water. *Acta Physiol. Scand.*, 18: 181-189, 5 fig.

## Physiological Aspects of Testing Contact Chemoreception. A Symposium

FLAVOR PERCEPTION BY CONSUMERS<sup>1</sup>

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Without recourse to anthropology, most of us have observed that food habits, the likes and dislikes of individuals, are often unpredictable and highly whimsical. Some of the whimsy may have been due formerly to large variations in food quality, which today are less noticeable as a result of increasing standardization of processed foods. The trend toward standardization has been paralleled by the trend toward mass production and distribution. All of these factors have increased the financial risks resulting from mistaken or biased flavor judgment on the part of the food packer who wants to "improve" his products or introduce new products. Consequently, more and more of us in the food business are bolstering our marketing decisions by some sort of statistical flavor evaluation. The statistical approach has been added to that of the expert taster, as traditionally employed by producers of tea, coffee, beer, and wine. The expert is respected for his ability to discriminate and describe flavor differences and to relate them to trade standards. However, the traditional expert's prediction of consumer opinion can often be biased and his errors remain undetected until too late if they are not frequently audited by a statistical check with trained panels or by consumer sampling.

*Use of Laboratory Panels.*—Taste panels are usually organized from laboratory or office staff members by a process of screening. For example, if the panel is to assess coffee quality, a group of about 30 candidates are presented first with known samples to demonstrate varying degrees of freshness, roast, varietal characters, etc. The same samples are later presented under blind code for identification of small differences by means of the triangular test — two identical samples plus one odd sample — for identification of the odd sample. Tests are set up to cover all the known commercially important variables and are repeated on different days. At the end of 20 to 30 such screening tests, the most successful 10 or 15 persons are selected as an operating coffee panel. Reference will be made later to the relative acuity of such a panel and of large consumer panels.

The function of a laboratory panel may be:

- (1) to detect any departure from standard quality, or to assess flavor intensity in terms of known standards (quality control)

<sup>1</sup> See footnote on page 14.

\* Paper received August 31, 1954.

- (2) to subjectively analyze a complex flavor into its attributes and to evaluate their relative intensities (flavor profile).

To illustrate one use of a panel, let us suppose that a research group has discovered a new way to formulate a flavor for a dessert product. Let us assume that there are several alternate directions in which this project can move, and it is desired to know whether this particular one should be pursued or dropped. Our first step is to determine whether the experimental sample really differs significantly from the standard. The new and standard products are submitted to a screened panel in a triangle test. If fewer than nine tasters out of a panel of 15 succeed in the correct identification, the experimental sample is judged to be so close to the standard that no further testing or development in this direction is warranted. Parenthetically, the question is frequently asked why the judgments of tasters who are unable to identify the odd sample should not be rejected. This can be answered by considering what happens if all three samples are identical. On the average, one-third of the tasters will succeed and two-thirds will fail to identify a designated sample, by chance alone. The point that is often overlooked is that correct identification can be an accident as well as an indication of taste sensitivity. This risk is properly assessed by statistical treatment of *all* the individual judgments.

It is often important to know whether a process change has produced a slight difference in flavor character. In such cases it is important to demonstrate the taste character to be determined, so that all tasters are agreed on the terms in which to express their opinions, before final selection of the screened panel. For example, the characteristics of bitterness and astringency are both important, but are difficult for the average taster to distinguish. In our experience, it was not until demonstrations were set up, using quinine and tannin solutions as models, that many panel members were able to assign the proper descriptive terms to the flavors they perceived.

It is also important to recognize that a panel judgment regarding the intensity of a specific flavor character does not necessarily provide any information as to how well the consumer will accept the product. We have discouraged the use of laboratory panels to measure preference alone, because of the unknown effects of individual prejudice and whimsy in such a small group. In general, we prefer to use the laboratory panel as an analytical tool to detect differences and to measure relative flavor intensities, leaving to the consumer panels the decision as to what the consumer likes.

*Fatigue.*—The effect generally known as fatigue has been discussed subjectively by many writers in the field of sensory evaluation. In organoleptic testing, it is characterized by diminishing ability of a taster to recognize small differences in flavor as tasting is prolonged.

In our laboratory, triangular tests are used extensively for routine difference evaluation of experimental and standard products. In order to obtain a maximum number of judgments and at the same time keep the cost of testing-low, two triangular tests are presented at one sitting.



Over the period of a year and a half, we have accumulated the results of 148 double triangular tests on a coffee product by an expert panel. In all of these, the sample pairs were the same for both triangles. In half of the tests, the odd sample of the first triangle was presented as the duplicated sample in the second triangle. In the other half, the odd sample of the first triangle remained the odd sample in the second.

These 148 sets of successive tests were compiled and tabulated into the contingencies shown in Table I.

TABLE I.—SUMMARY OF THE NUMBER OF SUCCESSES AND FAILURES IN A SERIES OF DOUBLE TRIANGULAR TESTS

<i>Results</i>	<i>First Triangle</i>	<i>Second Triangle</i>	<i>Both</i>
Successes .....	856	880	1736
Failures .....	863	839	1702
Total .....	1719	1719	3438

It is apparent that there is no lessening in sensitivity due to fatigue in this series. In fact, the total number of successes in the second set of triangles is even greater than in the first.

Fatigue has been evaluated under similar conditions for maple syrup. This product is considered by our trained panel to be one of the most difficult to taste because of its high level of sweetness.

A series of tests on blended maple syrup was conducted using double triangular tests. Results of this series of tests are shown in Table II.

TABLE II.—SUMMARY OF THE NUMBER OF SUCCESSES AND FAILURES IN A SERIES OF DOUBLE TRIANGULAR TESTS ON MAPLE SYRUP

<i>Results</i>	<i>First Triangle</i>	<i>Second Triangle</i>	<i>Both</i>
Successes .....	97	75	172
Failures .....	70	92	162
Total .....	167	167	334

The difference in results between the first and second triangles was examined by  $X^2$  analysis and found to be significant at the 2% level. This definitely suggests that fatigue was operating, since all other factors of variation were either randomized or controlled.

*Consumer Tests.*—As mentioned earlier, an analytical panel does not necessarily reflect consumer preference. When an experimental sample has been judged to be significantly different from the standard, yet not obviously defective, we have recourse to a short-cut method of consumer sampling. The control sample and an experimental variant are sent to one or another of several New York department stores where space is rented for this work. A staff of two to four trained interviewers invites customers of the store to participate in a "taste test". The respondents are asked to tell which of two blind-coded samples they prefer and, if possible, the reason for their choice.

The information thus obtained is used as a day-to-day or week-to-week source of guidance for the technologist attempting to improve old or develop new products. Principal advantages of this store test procedure lie in the relative speed with which results can be obtained and the comparatively low cost.

It has become standard practice to obtain at least 300 consumer judgments on a sample pair before concluding that a preference has or has not been demonstrated. Usually this can be done in one day's time.

*Correlation of Panel and Consumer Tests.*—During a two-year period we had occasion to examine about 76 different sample pairs of coffee by both laboratory panel and by store test. A breakdown of what occurred in these 76 matched tests is shown in Table III.

TABLE III.—COMPARISON OF PANEL AND CONSUMER PERFORMANCE

	Number	Per cent
Total Tests .....	76	100
Consumer Preferences .....	25	33
Panel Differences .....	30	40
Total Consumer Preferences...	25	100
Panel Differences .....	15	60
Panel Failures .....	10	40

The interesting part of Table III is the breakdown of the 25 cases in which consumers found a preference. It is not surprising for consumers to fail to show a preference for one of a pair of samples which a panel has found to be different. It is surprising at first glance for consumers to find a preference where a panel has failed to find a difference. Table III shows that this occurred 10 times (40%) in 25 cases of consumer preference.

The 5% significance level is not reached in a 300 judgment test until a preference of at least 55.7% for one sample is realized. In the 10 cases shown in Table III where the panel failed to find a difference, the average percent preference found in the consumer test was 58.3%. The range was 56.5% to 65.5%.

The question may be raised as to whether or not the expert panel we used was actually large enough in size for the task assigned to it. Table IV shows the number of tasters participating in the 10 cases of panel failure, together with the percentage success in each test.

It is interesting to note that Tests 3 and 9 were at chance level of 33% or below. For these tests, no increase in panel size, assuming the same percentage success, would ever yield a significant result. A simple calculation shows, however, that if a panel of 120 tasters had the same degree of success as shown in Table IV, eight of these cases of failure would have been considered to have shown a significant difference.

This indicates that, for this type of sample, under the conditions of testing described earlier, a panel test of at least 120 judgments is needed

to avoid the risk of missing differences corresponding to an average consumer preference of 58%.

TABLE IV.—RESULTS OF EXPERT PANEL WHICH WERE CONSIDERED FAILURES

<i>Test</i> No.	<i>Expert</i> <i>Panel Size</i>	<i>Expert Panel</i> % Success	<i>Level of</i> <i>Significance</i>
1 .....	26	42	.50
2 .....	14	50	.30
3 .....	16	31	>.50
4 .....	22	46	.30
5 .....	26	46	.30
6 .....	13	62	.06
7 .....	14	43	>.50
8 .....	13	62	.06
9 .....	48	33	>.50
10 .....	14	50	.40

These findings seem reasonable when one considers that the panel was selected as above average from twice its number of unscreened selectees. With an added advantage of training and experience in tasting, 120 judgments by this group is found to compensate for the added statistical advantage of 300 inexperienced consumers. This is a "sensitivity ratio" of about 1 to 3. By comparison, when researchers use panel tests of 15 to 30 judgments, a sensitivity ratio of 1 to 10 or 20 is required.

*Consistency of Store Test Results and Correlation with Home Use Tests.*—Although store test panels of at least 300 are recommended, it has been our practice to schedule the tests in units of 150 judgments each. Frequently the two halves of a test are run in different stores. Although the unit scheduling is governed by expediency rather than by deliberate randomization, it has been found that the differences between half-test results for a given sample pair do conform to the normal distribution of random error. Based on a total of 200,000 judgments accumulated over a period of 18 months, the error estimate for a 300 judgment paired preference is 10 percentage points.

When store test results appear encouraging, we usually recommend a nationwide consumer sampling by mail before changes in merchandising plans are authorized. Paired comparisons in the home are known to be subject to many more uncontrolled variables than are the local store tests, but they have the advantage of better representing, on the average, the actual conditions of use.

Statistical analyses are in progress to establish the expected error of a home use test and the correlation between store tests and home use. At present it can be said that, for the majority of products tested, the



store test provides a valid estimate of consumer acceptance, within the rather wide range of error which is characteristic of such sampling.

In all of the foregoing it is assumed that our objective is to win consumer acceptance over a standard or competitive product of high acceptability. It is interesting to speculate what would happen if a radically new (but not obviously objectionable) type of flavor were to be appraised. It is very probable that the techniques just described would never succeed in establishing a majority consumer acceptance for such a product. This would be expected for two reasons — (1) the unavailability of a standard having reasonably close resemblance to the new product, and (2) its probable rejection by the consumer because of lack of familiarity with the type. A decision to promote such a product today would require unusual courage, because no valid estimate of risk could be obtained until some degree of "consumer education" had been attained.

## Velocity of Propagation of Luminosity in Long Discharge Tubes <sup>1</sup>

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The propagation of luminosity and potential in long discharge tubes has been investigated by Thomson (1893), Beams (1930), Snoddy et al. (1936, 1937), Mitchell et al. (1947). The work to date has shown that the luminosity has the same propagation characteristics as the potential pulse; that it moves always from the high potential electrode; that the first discharge may be followed by a second of higher luminosity which originates at the low voltage electrode if the latter is grounded; that the velocity is highly dependent on voltage and pressure, showing a definite peak at some pressure which is characteristic of the gas. These characteristics are similar to the observed features of the lighting discharge (Schonland et al., 1934) and the long sparks which may be produced in high voltage laboratories (Allibone et al., 1938).

The present investigation of velocity characteristics of luminous discharges was undertaken to extend observations previously made in this laboratory (Beams, 1930; Snoddy et al., 1936, 1937; Mitchell et al., 1947). The velocity of the luminous pulse in discharge tubes 10 feet long, supported coaxially in 6 inch gutter pipe, was determined for air, argon, carbon dioxide, helium, hydrogen, nitrogen, and oxygen as a function of pressure, voltage, and electrode shape. Two tubes were used, of 6 and 12 mm. inside diameter.

### APPARATUS

The arrangement of the equipment used is indicated in the block diagram, Figure 1.

The high voltage power supply was a Marx circuit (Jacob, 1934: 7) which was calibrated by spark gap measurements.

The time interval between arrival of the luminosity at two points in the discharge tube was measured by means of photomultiplier tubes and a 300 ohm Twinlead transmission line along which 16 detector circuits such as are shown in Figure 2 were spaced at 2 foot intervals. This is a modification of the "chronotron" described by Keuffel (1949). The operation is as follows: when a negative signal is sent down the transmission line each detector produces an output pulse about 0.4 microsecond in length. These pulses are delayed 0.5 microsecond with respect to one another by delay lines and are then presented on a synchroscope. When

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<sup>1</sup> Supported by Navy Bureau of Ordnance Contract Nord-7873.

<sup>2</sup> Now at United Gas Corporation, Shreveport, Louisiana.

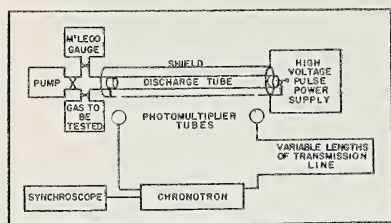


FIGURE 1 BLOCK DIAGRAM OF EQUIPMENT

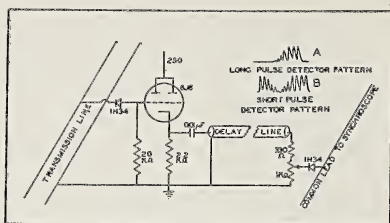


FIGURE 2 CIRCUIT DIAGRAM OF DETECTOR

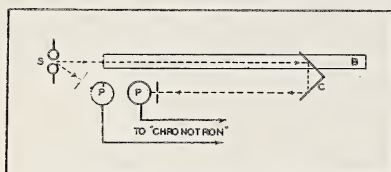


FIGURE 3 CALIBRATION DEVICE

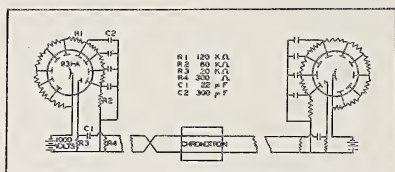
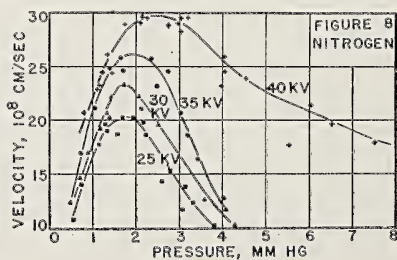
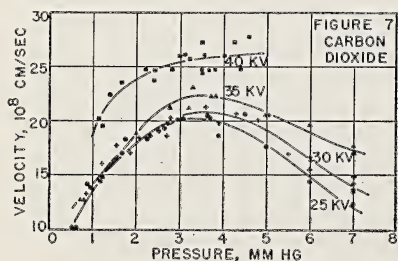
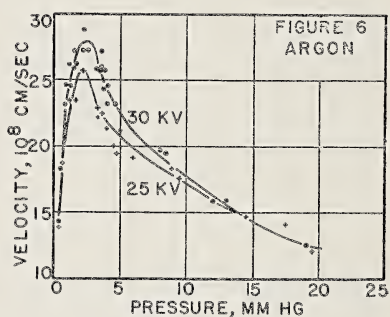
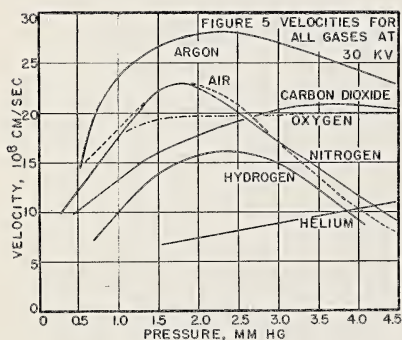


FIGURE 4 CIRCUIT DIAGRAM OF PHOTOMULTIPLIER TUBES





a positive signal is sent down the transmission line, the response of the detectors is too low to be observed, due to the polarity of the 1N34 crystals. If a positive signal is sent from one direction and a negative signal from the other, all of the detectors produce pulses except the ones on which the two signals are impressed simultaneously. An estimate of the signal length can be made, based on the contour of the pulse heights. This is apparent when one considers that a full negative signal is not presented to the detectors at some time only where the two signals are coincident in time and space. Hence in sketch A of Figure 2 one sees at once that the signals were longer than half the time interval represented by the detector spread, and that in sketch B the signals were coincident at seven detectors. If one of the transmission line signals is delayed with respect to the other, the meeting point will shift with a corresponding change in the output pattern of the detectors. By inserting known lengths of transmission line, using polarized connectors, the two signals can be made to meet at any detector desired, greatly extending the range of the instrument.

The system was calibrated with respect to the velocity of light in air by use of a spark gap and an optical bench as shown in Figure 3. By changing the position of the optical corner, C, known time delays could be introduced into either signal to the detector circuits. The corresponding shift in meeting point of the signals could be recorded, or the signal pulses could be made to meet at the same detector as before by inserting various lengths of transmission line. This procedure established the fact that the detectors did not change the velocity of signals on the Twinlead transmission line to a noticeable degree. The velocity on the transmission line of a signal with a rise time of  $3 \times 10^{-9}$  seconds was 0.92 times the velocity of light in air. Rise time as used here indicates the time from zero to maximum signal, as determined from the synchroscope pattern. It was found that the detectors functioned properly with a minimum of 3 inches separation, a limit set by the physical spacing of the detectors on the chassis. In the present work the 2-foot spacing of the detectors made it possible to read time intervals to an accuracy of  $1.1 \times 10^{-9}$  seconds, assuming the proper zero time.

The arrival of luminosity at any point in the discharge tube was recorded by means of 931-A photomultiplier tubes, the circuits for which are shown in Figure 4. Separate battery power supplies were used to present signals of opposite polarity but otherwise similar characteristics to the detector circuits. A slit arrangement limited the field of view of the photomultiplier tubes to about 1 mm. The photomultiplier tubes were spaced 7.0 feet apart, at 30 and 8 inches from the high and low voltage electrodes, respectively. A preliminary investigation of velocity as a function of position along the discharge tube showed that erratic effects observed in the first 40 cm (Beams, 1930) were not noticeable in the section used.

The various parts of the vacuum system could be isolated from one another as shown in Figure 1. A dry ice-alcohol cold trap was used to prevent mercury contamination from the McLeod gauge used to measure pressures.

Before taking data on any gas it was necessary to flush the system

several times. A fresh sample of gas was used for each observation, the system being pumped between discharges. The velocity of the luminous pulse fluctuated widely if this was not done. Velocity readings repeated, however, if the tube remained quiescent for some five minutes between discharges. The gases used were of standard commercial purity.

The low voltage electrode was normally connected to the ground through a 5000 ohm electrolytic resistor. If this resistor was shorted out, a luminous pulse was observed to originate at this grounded electrode up to 20 microseconds after the arrival of the initial pulse.

## RESULTS

The data are presented in graphical form in figures 5-14. All data shown were obtained with a 12 mm. diameter spherically ended brass electrode in the 12 mm. tube and a similar 6 mm. electrode in the 6 mm. tube. Unless otherwise specified, the data are those taken in the 12 mm. tube.

A conical ( $20^\circ$ ) high voltage electrode produced velocities much lower than did spherical electrodes; the curves were similar to those obtained with spherical electrodes at lower input potentials.

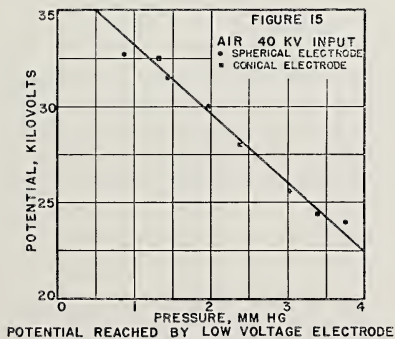
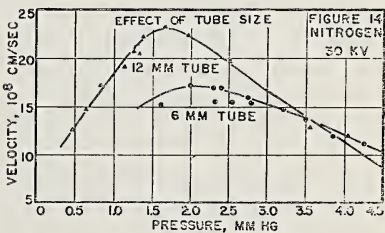
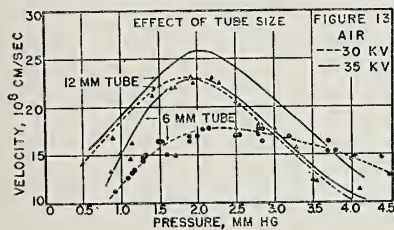
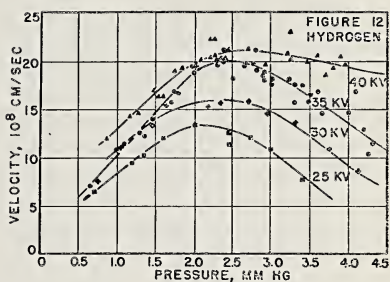
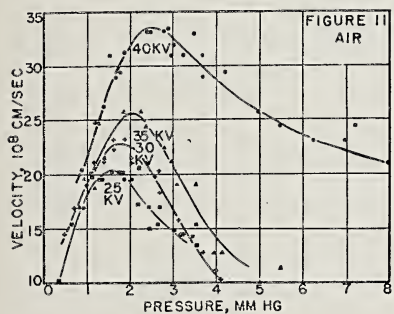
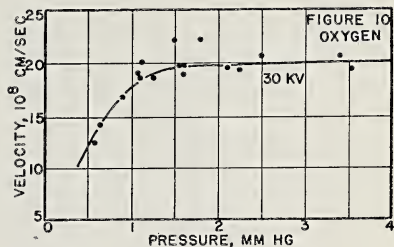
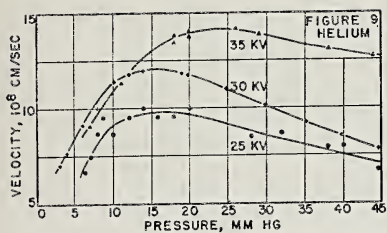
The spread of values of the data appears to be largely due to operator error in observing time intervals when the deviation is greater than the accuracy of the "chronotron". This explanation is not satisfactory for the larger deviations; such fluctuations have been noted previously (Snoddy et al., 1936, 1937; Mitchell et al., 1947).

## DISCUSSION OF RESULTS

The results of this investigation are in general agreement with the work referred to in the introduction. The principal contribution of this paper is the relative velocities of luminosity in various gases at a given potential, as shown in Figure 5.

The explanation of this ordering appears to be connected with efficiency of ionization by electrons in the gases. In this respect it is interesting to note the correlation of Figure 5 with plots of  $\alpha$ , the first Townsend coefficient, as a function of the energy of incident electrons (Compton et al., 1926: 724; Maxfield et al., 1941: 267). The relative magnitudes of maxima in the two sets of data as well as the two cross-over regions are the most striking points of correspondence.

One may construct a relatively simple qualitative description of the mechanism of propagation which explains the observed features of the data. Consider an intermediate point in the discharge tube at which the positive potential has just arrived. The intense luminosity in this region leads to production of photo-electrons in the undisturbed region ahead of the propagating potential front. These electrons are accelerated toward the front, ionizing by collision as they go. Both the conductivity of the discharge tube and the usual treatment of the spherical tipped discharge (Schonland et al., 1934; Meek, 1939) lead to values of ionization of the order of  $4 \times 10^{11}$  ions/cc. One may now make certain assumption as





to the magnitude and gradient of the net charge at any point in the tube. Calculated values of the gradient in volts/cm. for exponential, linear, and constant densities of net charge over various lengths, as well as the hemispherical tip assumption, show that in each case fields may be found over distances which, combined with reasonable values of  $\alpha$ , will produce an ionization of  $4 \times 10^{11}$  ions/cc. from a single photoelectron. While the exponential distribution appears to be the most probable one, none is outstanding so far as application to the present problem is concerned.

Assume for the present purpose that the field as a function of distance is the same for each gas at a given pressure (between 1 and 3 mm. of mercury) and potential. Ionization will then be more effective in the low field region for argon than for helium, or the ion density required for propagation of the potential will be developed in shorter distances from the point of origin of the initiating photoelectron, which corresponds to a higher velocity of the potential pulse. At higher potentials the optimum distribution of electron velocities will be attained in shorter mean free paths, or at higher pressures. This appears to be borne out by the shift of the velocity peak to higher pressures as the applied potential increases. As the pressure rises, however, the effective mean free path for photons decreases with a consequent decrease in velocity of the pulse. The preliminary investigation previously mentioned indicated a lower velocity as the luminosity moved away from the high voltage electrode. This is explainable on the basis of a lower potential due to the tube drop. The extent of this drop is indicated in Figure 15, in which the voltage drop across the 5000 ohm low potential resistor is plotted as a function of pressure. Since the input potential was constant, one sees that the tube drop increased linearly with pressure over this range. It should be pointed out in this connection that the velocities measured are of necessity the average velocities for the given conditions.

The extension of this treatment to a more exact quantitative development will require considerable data not yet available in the literature as to absorption coefficients of ionizing radiation in all of the gases, the net charge distribution, and the attenuation effect of the tube walls.

#### ACKNOWLEDGMENTS

The "chronotron" described in this paper was developed under the direction of the late Dr. L. B. Snoddy. The remainder of the work was done under the direction of Dr. J. W. Beams, Chairman, Department of Physics, University of Virginia. The author wishes to express his gratitude to these gentlemen and to other faculty members and fellow students whose comments and suggestions contributed to the successful completion of this work.

## REFERENCES

- ALLIBONE, T. E. AND J. M. MEEK. 1938. Development of the Spark Discharge. *Proc. Roy. Soc.*, A166, 97-126.
- BEAMS, J. W. 1930. Propagation of Luminosity in Discharge Tubes. *Phys. Rev.*, 36: 997-1001.
- COMPTON, K. T. AND C. C. VANVOORHIS. 1926. Probability of Ionization of Gas Molecules by Electron Impacts. *Phys. Rev.*, 27: 724.
- JACOB, L. 1934. High Voltage Physics. *Methuen and Co.*
- KEUFFEL, J. W. 1949. A Simplified Chronotron-Type Timing Circuit. *Rev. Scient. Inst.*, 20: 197-201.
- MAXFIELD, F. A. AND R. R. BENEDICT. 1941. Theory of Gaseous Conduction and Electronics. *McGraw Hill Book Co., Inc.*
- MEEK, J. M. 1939. The Mechanism of the Lightning Discharge. *Phys. Rev.*, 55: 972-97.
- MITCHELL, F. H. AND L. B. SNODDY. 1947. Ionization Processes in a Long Discharge Tube with Application to Lightning Mechanism. *Phys. Rev.*, 72: 1202-1208.
- SCHONLAND, B. F. J. AND H. COLLENS. 1934. Progressive Lightning. *Proc. Roy. Soc.*, A143, 654-674.
- SNODDY, L. B., J. R. DIETRICH, AND J. W. BEAMS. 1936. The Propagation of Potential in Discharge Tubes. *Phys. Rev.* 50: 469-471.
- , 1937. Propagation of Potential in Discharge Tubes. *Phys. Rev.*, 52: 739-746.
- THOMSON, J. J. 1893. Recent Researches in Electricity and Magnetism. *Clarendon Press*, 115.

## The X-Bivalent of the Golden Hamster

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The sex chromosomes of the golden hamster, *Mesocricetus auratus*, are larger than the other chromosomes of the complement. At the first meiotic metaphase in the male the x-chromosome is composed of a deeply staining portion, and a less contracted more lightly staining heterochromatic part. The y-chromosome stains deeply in its entirety and is smaller than the x. The deeply staining portion of these chromosomes is the pairing segment, and the more lightly staining portion of the x, the differential segment (Koller, 1938). The retarded development of the differential segment is associated with the formation of gyres smaller in diameter and more numerous than the precociously developed spiral of the pairing segment. A chiasma is found between the long arm of the y and the x in 81.6 percent of the bivalents. The remainder have a second chiasma between the short arm of y and the portion of the x proximal to the differential segment (Koller, 1938).

In spermatogonial divisions the two largest chromosomes, assumed by Koller (1938) to be the x and y, were described as morphologically indistinguishable and having subterminal centromeres. Husted, Hopkins, and Moore (1945) found the two largest chromosomes of oocyte nuclei undergoing mitosis to have clearly submedian centromeres and an arm ratio of 1:1.9. Since the pairing segment of the y-chromosome at meiosis in the male is the longer arm and is seen to be equal in length to the deeply stained portion of the x, and since Koller had reported the x and y indistinguishable in size in spermatogonial divisions, Husted, Hopkins and Moore (1945) concluded that the differential segment of the x when fully contracted is a part of the shorter arm.

In the male, chiasmata can form only between pairing segments of the x and y. In the female where two x-chromosomes occur, it is to be expected that chiasmata may form between differential as well as pairing segments. According to Husted, Hopkins and Moore (1945) the differential segment of the x is not heterochromatic at mitosis and meiosis in the female. This segment resembles the pairing segment in being contracted and also staining deeply. Husted, Hopkins and Moore (1945) have presented evidence, admittedly inconclusive, that chiasmata are localized between the short arms of the x-chromosomes. All of the x-bivalents they encountered, 6 in number, were associated by chiasmata between short arms.

It seems desirable to extend these observations to determine if chiasma localization does in fact exist in the differential segment of the female hamster. It is with this feature that this paper is primarily concerned.

\* Paper received August 4, 1954.



## MATERIALS AND METHODS

The mammalian ovary has been seldom used in chromosome studies because meiotic and mitotic divisions are less frequently found there than in the testes of the male. The chromosomes in oocytes, however, are more widely spread on the spindle and their structure more easily studied than in the crowded spermatogonial cells and spermatocytes. In hamsters 5-7 weeks of age numerous oocyte nuclei are found undergoing mitosis or meiosis. In older animals the number is reduced considerably. The mitotic divisions occur in follicles that usually, if not always, degenerate. Some of the oocyte nuclei undergoing meiosis will likewise degenerate, but no changes were revealed by the methods here used that must be considered to alter the behavior or structure of the chromosomes.

The ovaries from 20 ether-anesthetized hamsters, ranging in age from 5 weeks to 6 months, were removed and fixed in San Felice's solution for 4 hours. They were washed in 70 per cent alcohol, and stained by means of the Feulgen reaction. After bleaching in  $\text{SO}_2$  water, the ovaries were dehydrated in ethyl alcohol, cleared in chloroform, embedded in paraffin and sectioned at  $30\ \mu$ .

The testes from two sexually mature males were removed and cut into small pieces. The material from one male was immediately fixed in Carnoy, while portions of the other were placed in hypotonic solutions of sodium chloride for 20 minutes before fixation. Pretreatment with 0.5 percent sodium chloride facilitated the spreading of the chromosomes. Four drops of 4 percent iron alum for each 10 ml. of fixative intensified the staining of the chromosomes with aceto-carmin.

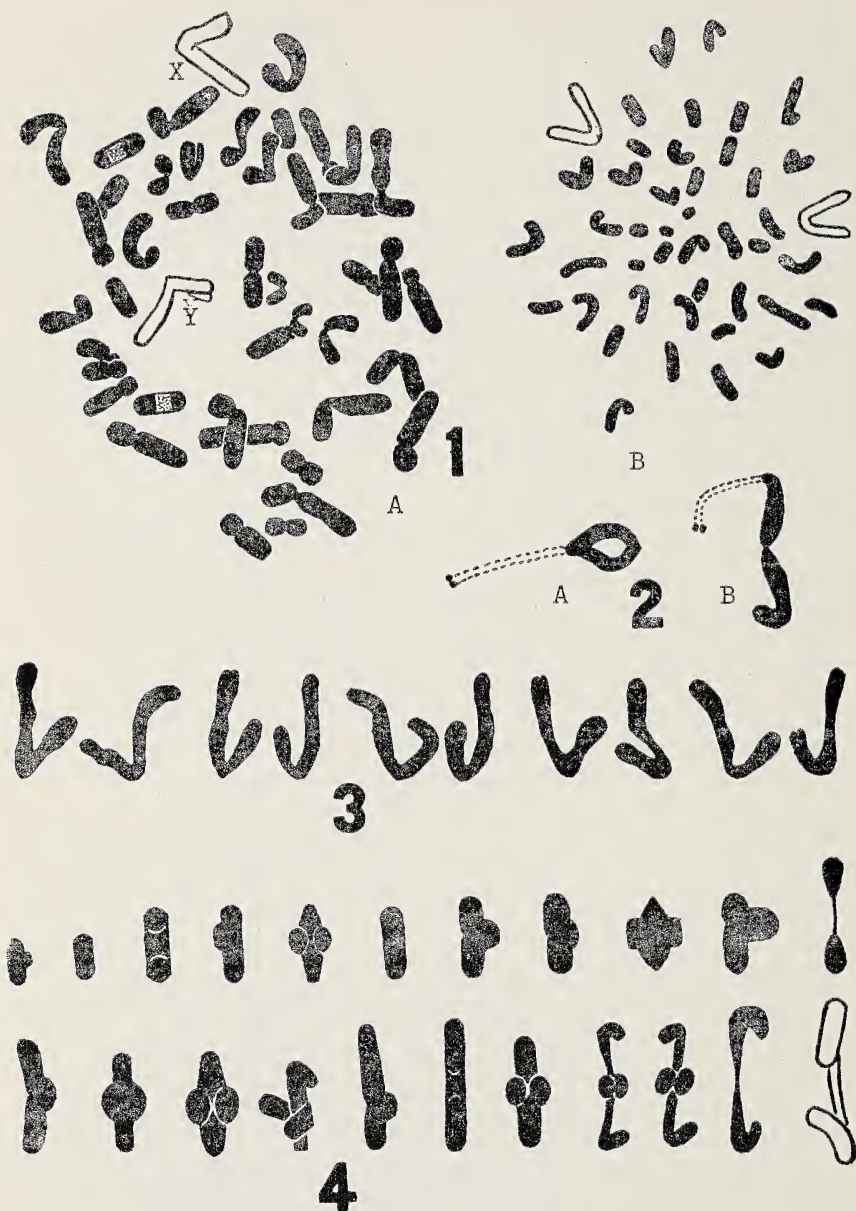
Observations were made with a Zeiss microscope equipped with 10x, 20x, and 30x oculars and 90x (n.a.1.3) oil immersion objective. Drawings were made with the aid of a camera lucida.

## OBSERVATIONS AND CONCLUSIONS

The somatic chromosome number of the golden hamster is 44 (Figures 1 A and B). This is in agreement with the determination in the female made by Husted, Hopkins and Moore (1945) and in the male by Matthey (1951) and Sachs (1952) but contrary to the reports of Koller (1938, 1946) and Muldal (1948).

*The male.*—The largest chromosome in the male complement (Figures 1 A and 3) measures approximately  $7.1\ \mu$  in length and is submedianly constricted. The next largest measures approximately  $6.5\ \mu$  and is easily distinguishable from the former. The difference between these two chromosomes is seen not in their longer arms which are equal in length, but in their shorter arms, (Figure 3). Since these chromosomes are unequal in size, and the largest, and meiotic studies in the male show that the heteromorphic bivalent which is considered the x-y bivalent is the largest of the complement, it is apparent that these chromosomes seen in spermatogonial divisions are the x and y.

The differential segment, which is seen as a less contracted, lightly staining region of the x at meiosis in the male (Figure 2, A and B),



does not stain lightly in spermatogonial divisions (Figures 1 A, and 3) nor is it less contracted. Since the arm of the x that stains deeply, and the long arm of the y are equal in length, and since in spermatogonial divisions the difference between the largest chromosomes designated the x and y is found to be only in their short arms, we must conclude that the differential segment of the x-chromosome is represented in the spermatogonial cells as the difference in length of the *short arm* of the x and y. The differential segment when contracted represents approximately 0.5  $\mu$  or 7 percent of the length of the entire chromosome.

*The Female.*—In the female the two largest chromosomes at mitotic metaphase are submedianly constricted as seen in the only polar view of metaphase that has been found in the course of this study. Husted, Hopkins and Moore (1945) have reported two divisions of this kind which likewise show the largest chromosomes to be submedianly constricted. In both the present account and the one here cited the short arms of the largest chromosomes are longer than the short arm of the chromosome that has been designated the y in the male. It seems clear that these two chromosomes in the female are the same as the one that has been designated the x in the male.

The differential segment, which stains intensely and is contracted in the spermatogonial cells of the male, stains similarly in the oocyte. There is a suggestion, as seen in Figure 1 B that the short arm of the x is less contracted in the mitosis of the female than in the spermatogonial cells of the male, (Fig. 1 A). Although there may possibly be a tendency here for less complete contraction, the staining reaction in all parts of the chromosome is the same.

*Chiasma localization.*—Oocytes undergo the first meiotic division in various parts of the ovary. In all of these suitable for study, 40 in number, the largest chromosomes, here designated the x-bivalent, are associated by one or more chiasmata between the shorter of the two arms (Figures 4-25). The x-bivalents illustrated here have their long arms in many cases foreshortened and their short arms attenuated as a result of anaphase movement. In each case where foreshortening occurs the method of Levitsky was used to determine the actual length of the foreshortened arm. Figure 10 shows an x-bivalent which lies in one plane while Figure 22 has the free arm at the upper end and to the right greatly foreshortened. Both free arms of this, and of all the other bivalents, are equal in length. Figures 17 and 18 are examples of x-bivalents with both free arms greatly foreshortened. In no oocyte were x-chromosomes associated by long arms nor were any ring bivalents found. There is in the female hamster complete or nearly complete localization of chiasmata in the shorter arm. This is the arm which is considered to include the differential segment.

*Chiasma frequency.*—In the male hamster, Koller (1938) has found that 8.3 percent of the x- and y-chromosomes fail to form chiasmata and are unpaired at metaphase. In the female, no unpaired chromosomes were encountered. In the male, the average chiasma frequency in the xy-bival-





ent is reported to be 1.08 (Table I), while the average frequency in the autosomal bivalents is 1.33 (Koller, 1938).

TABLE I.—CHIASMA FREQUENCY IN MALE AND FEMALE HAMSTERS

Sex	Bivalents	No. of Bivalents	Total Chiasmata	Chiasma freq. per bivalent
Male*	xy	276	300	1.08
	Autosomal	180	240	1.33
Female	xx	40	55	1.38
	Autosomal	132	193	1.46

In the female the 40 x-bivalents studied showed 1.38 as the average number of chiasmata between short arms. The autosomal bivalents had a mean chiasma frequency of 1.46. There are more chiasmata formed between both x-chromosomes and between autosomal bivalents in the female than in the male. This is in agreement with the cytological results found by Koller (1932) in the mouse.

The conclusion has been reached that in the female hamster chiasmata are localized between arms which include the differential segment, and that the arms which constitute the major portion of the pairing segment in the male, fail to form chiasmata in the female.

There is only one alternative to this conclusion: namely, that the chiasmata of the x-bivalents are localized between the arms which represent the pairing segment. This alternative demands the assumption that in the female hamster the long arm of the x-chromosome (the pairing segment) contracts differentially and to such an extent that it appears to be a short rather than a long arm. Since there is no evidence for extreme contraction of the x-bivalent relative to the autosomal bivalents this assumption is considered unlikely.

### SUMMARY

The x-chromosome of the golden hamster at meiosis in the male consists of a deeply staining pairing segment and a more lightly staining, slender, elongated differential segment. At the spermatogonial divisions the entire x-chromosome is contracted and stains uniformly. The differential segment in these divisions represents approximately 7 percent of the x-chromosome and is indistinguishable from the pairing segment. In the female hamster, the two x-chromosomes are uniformly contracted and the differential segment is indistinguishable as in the spermatogonial mitosis. Chiasmata at meiosis are formed only between the short arms of the x-chromosomes and hence are localized in those arms which are partly made up of the differential segment. The arm of the x, which in its entirety has no counterpart in the y and consequently the distal portion of which cannot undergo crossing over in the male, is the arm in which chiasmata are localized in the female.

\* Data from Koller, 1938.

## LITERATURE CITED

- HUSTED, L., J. T. HOPKINS, AND M. D. MOORE. 1945. The X-Bivalent of the Golden Hamster. *Jour. Hered.*, 36: 93-96.
- KOLLER, P. C. 1932. Sex-Differences in Crossing-over and Chiasma-Frequency in the Mouse. *Nature*, 130: 242.
- , 1938. The Genetical and Mechanical Properties of the Sex Chromosomes. IV. The Golden Hamster. *Jour. Genet.*, 36: 177-195.
- , 1946. Control of Nucleic Acid Charge on the x-Chromosome of the Hamster. *Proc. Roy. Soc. B.*, 133: 313-326.
- MATTHEY, R. 1951. Chromosomes de Muridae. *Experimentia*, 7: 340.
- MULDAL, S. 1947. John Innes Horticultural Institution. *Ann. Rept.* 38: 22-23.
- SACHS, L. 1952. Polyploid Evolution and Mammalian Chromosomes. *Hered.*, 6: 357-364.



## The XY-Bivalent in *Chinchilla laniger*

JESSE THOMPSON

*Department of Biology, University of Virginia*

*Chinchilla laniger* is a small rodent native to the South American Andes. Its soft, thick fur has led to its domestication and introduction into the United States where it now has become of some economic importance.

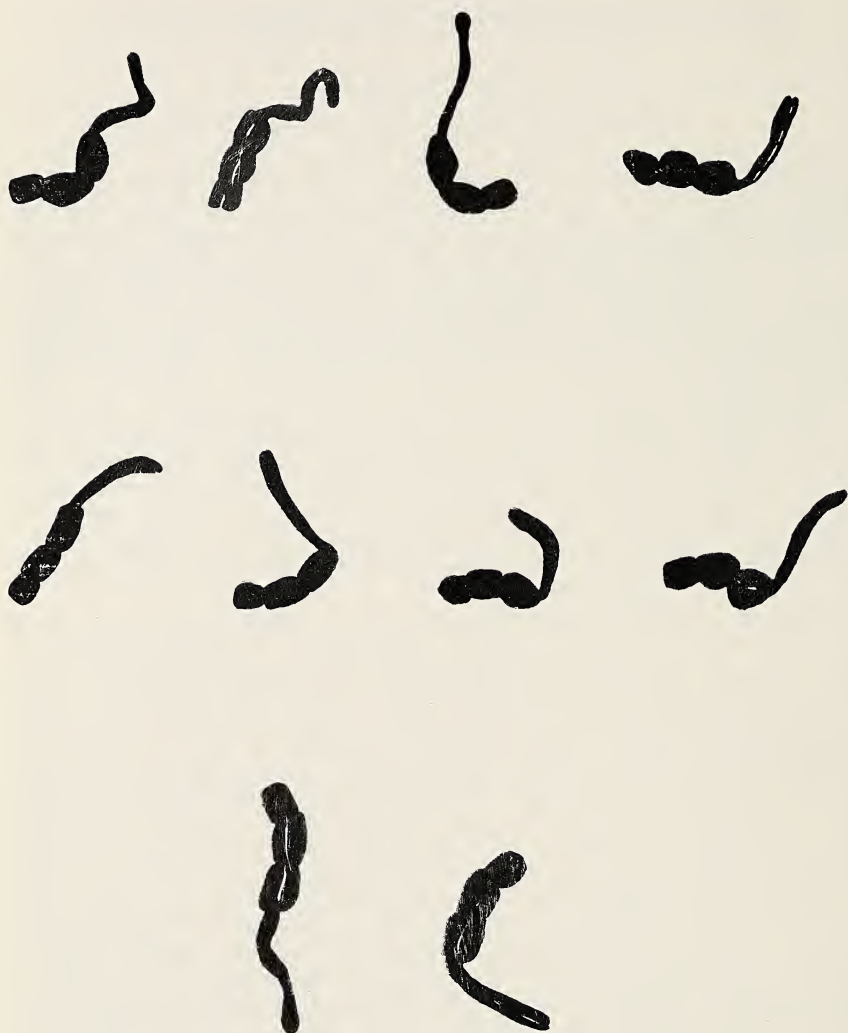
The chromosomes are known only through the work of Makino (1953) who has reported the diploid number to be 64 and has designated the X and Y chromosomes at metaphase in a spermatogonial cell. Makino has also reported a "heteromorphic XY-complex which consists of a larger v-shaped X and a smaller v-shaped Y coming into contact by their shorter arms."

Through the kindness of Gordon F. Harris (Charlottesville), C. W. Haga (Front Royal) and Tom Farrow (New Market), Virginia, the material was made available to study the chromosomes in the male and to some extent in the female animal. The results of this study are not in agreement with the conclusions of Makino and furthermore show a striking similarity between the sex bivalent of the Chinchilla and the Golden Hamster as described by Koller (1938).

Testes were removed from ether anesthetized animals and immediately fixed in the 6:3:1 solution of Carnoy while being teased into small pieces. The tubules were refrigerated until ready for staining by means of the aceto-carbim technique of Painter (1939). Observations were made with a microscope equipped with 10x and 15x oculars and a 95x (n.a. 1.25) oil immersion objective. All drawings were made at table level with the aid of a camera lucida and are reproduced at a magnification of 2366x.

Fourteen sex bivalents have been examined at late diplotene, diakinesis, and metaphase I. The X and Y are associated in each by a terminal chiasma between the longer arm of the Y and the arm of the X which is identical as to length with the pairing segment of the Y. The Y-chromosome has a submedian centromere and an arm ratio of approximately 1:1.3. The larger X-chromosome consists of a pairing segment which is of the same diameter as the Y-chromosome and a longer arm which is differentially contracted. The gyres of the differentially contracted portion are approximately one-half the diameter of those in the pairing segment. The more slender arm presents an appearance similar to that of the differential segment of the X-chromosome of the hamsters that are known. The arm of the X-chromosome that is associated with the Y comprises 26 percent of the entire chromosome at meiosis I and the differentially contracted arm 74 percent.

Contrary to the observations of Makino the X-chromosome shows a pronounced differential contraction and is associated with the longer arm of the Y. From Makino's figure it appears likely that he has wrongly interpreted the differential segment to be the Y-chromosome and a portion of



LEGEND TO FIGURE 1.—Ten XY-bivalents from the male chinchilla in late diplotene or diakinesis showing the Y-associated with the X-chromosome by a terminal chiasma. One arm of the X is differentially contracted. 2366x.

the pairing segment of the X. The differential segment appears to be the same diameter as that portion of the bivalent which is described here as the pairing segment of the X and the Y-chromosome.

The X-chromosome as seen in spermatogonial division is the largest chromosome of the complement and is not differentially contracted. This is likewise the situation in the Golden Hamster, *Mesocricetus auratus* as represented by Koller. The Chinchilla should be excellent material for the study of X-bivalent behavior during meiosis in the female since the X-bivalent can be easily distinguished from the autosomes.

#### LITERATURE CITED

- KOLLER, P. C. 1938. The genetical and mechanical properties of the sex chromosomes in the Golden Hamster. *Jour. Genetics*, 36: 177-195.
- MAKINO, S. 1953. Notes on the chromosomes of the Porcupine and the Chinchilla. *Experimentia*, 9: 213-214.
- PAINTER, T. S. 1939. An aceto-carmin method for bird and mammalian chromosomes. *Science* 90: 307-308.



## News and Notes

(EDITOR'S NOTE: *News contributions should be sent to the person whose name appears at the end of the appropriate section.*)

### JUSTUS HENRY CLINE

October 14, 1875 - July 26, 1954

The Nation, the State, and the Virginia Academy of Science lost a noble scientist and teacher on July 26, 1954, with the death of Justus Henry Cline at the age of 78.

Loved and respected by all, his wise counsel was sought by young and old alike. He was acclaimed throughout the nation for decades because of his foresight, inspiration, energy, and unselfish interest in science in general and conservation in particular.

His monument is in the Uinta Basin, the Big Levels Game Refuge, The James River Monograph, and the dam for the South River Water Supply System.

MARCELLUS H. STOW

### A LETTER FROM THE PRESIDENT

Your President takes this opportunity to make two announcements of general interest to the Academy. The first is that the Virginia Journal of Science has now reached its fifth birthday and after a series of growing pains is rapidly approaching maturity. During this period of growth the two men most responsible for the Journal have been Boyd Harshbarger and Horton Hobbs. It is with sincere pleasure that the Council of the Academy announces that both Messrs. Hobbs and Harshbarger have agreed to continue to guide the destinies of the Journal for another period of five years.

Those attending the 1954 meeting of the Academy at Charlottesville will recall the gracious invitation of Dr. Tyler Miller, President of Madison College, to hold our 1955 meeting at that institution. This invitation has been accepted and the dates will be May 12, 13, and 14. Following is a list of the membership of the local committee on arrangements for 1955. It is suggested that specific information may be obtained from the proper person in this group.

## LOCAL COMMITTEE ON ARRANGEMENTS

Madison College, May 1955

J. E. Ikenberry-- <i>General Chairman</i>	Wilbert Chappell-- <i>Meeting Rooms</i>
B. W. Partlow-- <i>Housing</i>	<i>and Equipment</i>
W. L. Mengebier-- <i>Registration</i>	Raus Hanson-- <i>Geology Field Trip</i>
Murl Shawver-- <i>Traffic and Parking</i>	A. M. Showalter-- <i>Biology Field</i>
J. C. Wells-- <i>Junior Academy Exhibits</i>	<i>Trip</i>
E. D. Miller-- <i>Commercial Exhibits</i>	S. C. Bocksey---- <i>Signs and Maps</i>
	R. D. Cool-- <i>Chemical Industry</i>
	<i>Tour</i>
	C. P. Shorts----- <i>Information</i>

May I hope that a large number of you will be able to attend this meeting and become acquainted with yet another of the fine colleges of our state.

I. G. FOSTER, *President*

## PROPOSED CHANGES IN THE BY-LAWS

Section 5. The Virginia Journal of Science:

ARTICLE 5. The staff shall be composed of an Editor, an Associate Editor, Managing Editor, and an Advertising Manager — all elected by the Council — . . .

ARTICLE 5. The Editor shall receive all materials for the Journal, shall send scientific articles to the appropriate Sectional Editors for refereeing, shall act as a referee himself, and shall edit all material published in the Journal.

The Associate Editor shall aid the Editor in preparing materials for the Journal and in correcting proofs.

The Managing Editor shall keep mailing lists that are up-to-date, shall mail all Journals (including Proceedings), shall keep financial accounts on the Journal, shall pay all bills and care for all business, including an annual audit of Books of the Journal — subject to the regulations and approval of the Academy Council.

The Advertising Manager shall be responsible for securing the proper amount and type of advertising material for the Journal, and shall be responsible to the Managing Editor.

The Sectional Editors shall aid the Editor and Associate Editor in refereeing, and in securing additional referees for scientific articles within their respective fields; in preparing proper announcements and news items for the Journal; and in such other ways as may be advantageous.

## SECTION NEWS

## AGRICULTURAL SCIENCE SECTION

The Animal Science Conference organized for the purpose of acquainting the faculty of the School of Agriculture with research conducted in this field is again meeting weekly on campus: Staff members of the Departments of Animal Husbandry, Biology, Biochemistry and Nutrition, Dairy Husbandry and Poultry Husbandry participate in the presentations.

Dr. K. A. Huston, dairy cattle breeding extension specialist in the Department of Dairy Husbandry, has resigned to accept a position in research and teaching at Kansas State College. The effective date of his resignation is November 1, 1954.

The newly organized Milk Producers Federation has as its executive secretary Professor R. G. Connelly of the Department of Dairy Husbandry. Professor Connelly is on a six months' leave of absence from his duties as extension dairyman to assume this position.

The Southern Regional Collegiate Dairy Products Judging Contest was held on the Virginia Polytechnic Institute campus on October 22, 1954. The Department of Dairy Husbandry acted as host. Ten teams from various southern colleges participated in the contest.

A new pipeline milker and bulk milk holding tank were installed in the new dairy barn in July. The Department of Dairy Husbandry is now in the process of investigating the cleaning and sanitizing of milk pipe lines and conducting time-motion studies on pipe line milkers.

Mr. Earl T. Swink has been appointed Professor and Head of the Department of Agricultural Engineering at Virginia Polytechnic Institute effective July 1, 1954. Mr. Swink has been employed by the Extension Service since April 1, 1935. He received his B.S. and his M.S. degrees here at the Virginia Polytechnic Institute. At the time he was appointed as head of the department he was serving as Extension specialist in rural electrification.

Dr. Wilson B. Bell has been appointed as Associate Director of the Virginia Agricultural Experiment Station. Dr. Bell will continue to conduct research in animal diseases.

Dr. John Pendleton of the Agronomy Department at the Virginia Polytechnic Institute has published a challenging paper entitled "Background For Agronomy." This paper discusses some of the problems facing educators. The paper appeared in *Agronomy Journal*, September, 1954.

Dr. H. A. Rollins, Jr. has been appointed Associate Professor of Horticulture at Virginia Polytechnic Institute. Dr. Rollins is a native of Connecticut and received his Doctor's degree from Ohio State University at the end of the summer quarter 1954. He will be located at the Winchester Fruit Research Laboratory where he will conduct research and serve as Extension fruit specialist.

Dr. Anthony Lopez has been appointed Professor of Fruit and Vegetable Processing at Virginia Polytechnic Institute. Dr. Lopez came to Virginia from the University of Georgia. He received his Doctor's degree in Food Technology from the University of Massachusetts.



Mr. Arthur L. Eiser, Jr. has been appointed Research Instructor of Horticulture at Virginia Polytechnic Institute. Mr. Eiser will assist with the operation of the Arboretum at the Horticultural Farm. He is a native of Illinois and received his Master's degree from Iowa State College.

The Animal Nutrition research group at Virginia Polytechnic Institute has developed a method of predicting the toxicity of the highly chlorinated naphthalenes by feeding them in special diets to laboratory rats. In this work it was established that a diet rich in protein protects the animals to some extent against poisoning by these compounds. This work is summarized in a paper that will be published shortly in *The Journal of Nutrition*.

The Bacteriology research group at Virginia Polytechnic Institute is working on the manner in which bacteria decompose cellulose. This process is vital to high roughage feed utilization by livestock, soil humus formation, and waste disposal in the pulp and paper industry. Apparently, the breakdown occurs simultaneously anywhere along the plant fibre, rather than by cutting off small fragments from one end. A new product of cellulose breakdown, which is thus far only of theoretical importance, has been discovered.

Dr. W. A. Hardison of the Department of Dairy Husbandry is presenting the results of a cooperative study with the Department of Biochemistry and Nutrition and the Department of Statistics at the annual meeting of the American Society for Animal Production in Chicago on November 26, 1954. Results of an extensive experiment designed to establish the reliability of short-cut methods for determining the digestibility of feedstuffs by cattle will be presented.

Dr. W. E. C. Moore has recently joined the Department of Biochemistry and Nutrition at Virginia Polytechnic Institute. Dr. Moore will be two-thirds time on teaching staff in Bacteriology and will devote one-third time to Virginia Agricultural Experiment Station research on rumen micro-organisms.

Dr. James H. Bywaters and Dr. Clayton E. Holmes of the Virginia Polytechnic Institute Poultry Department attended the annual meeting of the Technical Committee of the Southern Regional Poultry Breeding Project at the University of Georgia on the 4th and 5th of October. Dr. Bywaters is the Virginia representative on the Committee. During the meeting the new Southern Regional Poultry Testing Station was inspected by the twelve man Committee and their associates. This testing station is a cooperative project between the 13 southern states and the Research Service of the United States Department of Agriculture and is designed to test, under common conditions, the several strains of chickens independently developed at each station. The Virginia Agricultural Experiment Station will have 3 or 4 strains on test in the 1955 season.

Calvin C. Craighead was appointed to the position of Plant Superintendent and Instructor in Poultry Husbandry in July. He completed the requirements for a B.S. degree in Poultry Husbandry during the first term of summer school 1954.

Denver D. Bragg was moderator of a panel which discussed "The Extension Poultry Specialist's Responsibility to Improve 4-H Poultry Club Work" at the annual meeting of the Poultry Science Association which was held at Purdue University in July. Lee W. Herrick and Dr. James H. Bywaters also attended this meeting.

R. S. Westing, Jr., Extension Swine Specialist at the Virginia Polytechnic Institute, resigned from the Animal Husbandry Department effective November 1 to work with the Augusta County, Virginia Farm Bureau as Agricultural Field Man. Dr. T. J. Marlowe has been appointed Associate Professor in Animal Husbandry Research at the Virginia Polytechnic Institute. He will do Record of Performance work with beef cattle. He received his Ph.D. degree from Oklahoma Agricultural and Mechanical College.

Dr. Martin J. Burrus, formerly on the Animal Husbandry Staff, Oklahoma State, has been appointed Associate Professor in Animal Husbandry Research at Virginia Polytechnic Institute. He will be located at the Front Royal Station where he will be doing animal breeding work.

Mr. Jack Taylor has been transferred to Virginia Polytechnic Institute from Front Royal to take the place of Frank McLaugherty, Instructor in Animal Husbandry, who was promoted to Director of the Field Station at Emory, Virginia.

R. C. Carter, Animal Geneticist in Animal Husbandry, has been recently appointed on the newly formed technical committee which coordinates sheep research in the south. He will be Virginia representative on this regional planning.

David Meyerhoeffer has been appointed Research Instructor of Animal Husbandry at Virginia Polytechnic Institute. Mr. Meyerhoeffer will be located at Front Royal. He received a B.S. degree in General Agriculture at Virginia Polytechnic Institute in June 1954.

Mr. John Henry Carter has been appointed Research Instructor of Animal Husbandry at the Tidewater Research Station. Mr. Carter received his B.S. degree from Virginia Polytechnic Institute in June 1954.

Dr. C. M. Kincaid will give a paper on performance testing work at the November meeting of the American Society of Animal Production in Chicago. Dr. Tom J. Marlowe will present a paper on research in Dwarfism at the same meeting.

A paper entitled "Correlation of Rapid Soil Tests with Chemical Composition and Yield of Hay and Pasture Crops in Virginia" by R. K. Stivers, C. I. Rich, and R. E. Blaser of the Agronomy Department, Virginia Polytechnic Institute, was presented at the annual meeting of the American Society of Agronomy and Soil Science Society of America at St. Paul, Minnesota, November 8-12, 1954.

WESLEY P. JUDKINS, *Virginia Polytechnic Institute*

#### ASTRONOMY, MATHEMATICS, AND PHYSICS SECTION

Professors Edward J. McShane and Gordon T. Whyburn attended the International Mathematics Conference in Amsterdam in August 1954. They

were appointed by the National Science Foundation as representatives of the United States at this meeting.

The Department of Astronomy at the University of Virginia held a NEIGHBORS MEETING on October 22-23 which was attended by some 30 astronomers from the eastern and southeastern sections of the country. Informal discussions were held on various topics in astronomy.

Dr. Heinrich Eichhorn, who received his Ph.D. at the University of Vienna, has joined the staff of the Leander-McCormick Observatory for the 1954-55 session. He holds a National Science Foundation fellowship and will study motions of stellar associations. Miss Marguerite Risley of Randolph Macon Women's College is also working at the Leander-McCormick Observatory with members of the staff for the current session.

Dr. Stephan Berko, who spent the past year at Princeton University as a National Research Foundation Post-doctoral Fellow, has joined the faculty of the Department of Physics at the University of Virginia where he will continue work in nuclear physics.

Dr. John W. Stewart, who received his Ph.D. in June 1954 at Harvard University, has been awarded a post-doctoral fellowship in physics at the University of Virginia. Dr. Stewart will continue his work on the compressibility of solidified gases at liquid helium temperatures.

National Science Foundation Pre-doctoral Fellowship for the current session have been awarded to Messrs. John B. Breazeale and Melvin M. Levine, graduate students in physics at the University of Virginia. New basic research contracts have been awarded the Department of Physics of the University by the National Science Foundation and the Atomic Energy Commission. The National Science Foundation contract is for the sum of, \$9,800.00 to support work by Professor J. W. Beams on molecular weight measurements by the ultracentrifuge method. The Atomic Energy Commission contract totalling \$37,500.00 will support work by Professor Frank L. Hereford and Stephan Berko on interactions of polarized gamma rays. This program will include installation of a low energy, high current Van de Graaff machine. The Atomic Energy Commission has also awarded two other proposals for research contracts at the University of Virginia. Professors Nicolas Cabrera and Allan T. Gwathmey will receive support for their work on nearly perfect crystals. Also the Ordnance Research Laboratory, which is associated with the Department of Physics, will receive support of work involving new centrifuge techniques.

F. L. HEREFORD, *University of Virginia*

#### BACTERIOLOGY SECTION

The 199th meeting of the Washington Branch of the Society of American Bacteriologists was held jointly with the Maryland and Virginia Branches on Saturday afternoon and evening, October 23, 1954, at the Army Medical Service Graduate School. The following program was presented. (1) Studies on the Mechanism of T-2 Bacteriophage Infection — Roger M. Herriott, School of Hygiene and Public Health, Johns Hopkins University. (2) The Sterilization of Culture Media Ingredients with Ethylene



Oxide — Leo F. Judge, Michael J. Pelczar — Department of Bacteriology, University of Maryland, College Park, Maryland. (3) Some Observations on the Nucleic Acids of Entozoic Amebae — Virginia J. Fuller, Angus M. Griffin — Department of Bacteriology, Hygiene and Preventive Medicine, George Washington School of Medicine, Wash., D. C. (4) Effect of Aeration Level on Sporulation of Aerobic Bacilli — Norman B. Roth, David H. Lively, and Howrad M. Hodge — Camp Detrick, Frederick, Maryland. (5) A Paper in Reference to Virology — Thomas C. Ward, School of Hygiene and Public Health, Johns Hopkins University. (6) Xylose Dissimilation by *Propionibacterium pentasaceum* — Wesley A. Volk, University of Virginia School of Medicine, Charlottesville, Virginia. (7) Tissue Culture in Microbiology — Karl Habel, Chief of Basic Studies Section Laboratory of Infection Diseases in the National Microbiological Institute of the National Institute of Health.

J. DOUGLAS REID, *Richmond*

#### BIOLOGY SECTION

Mr. Heiden T. Cox, having spent a year on leave to serve as Deputy Executive Director of the American Institute of Biological Sciences, has returned to the Virginia Polytechnic Institute.

Mr. Frederick S. Orcutt, who has been on leave of absence to serve as Professor of Bacteriology at the University of Hawaii, has returned to his position at the Virginia Polytechnic Institute.

The Virginia Polytechnic Institute announces the completion of a new research laboratory for animal diseases which has been constructed on the Price's Fork Road near Blacksburg. The research in the new laboratory is directed by Mr. Wilson B. Bell.

Mr. A. A. Muka joined the staff of the entomology section at the Virginia Polytechnic Institute as associate professor. Mr. Muka was recently awarded the doctorate at Cornell University.

Mr. Horton Hobbs, University of Virginia, was elected a member of the American Society of Naturalists at its last meeting in recognition of his excellent contributions to the field of crayfish ecology, distribution and evolution.

Mr. John Bayard Burch received the Master's degree from the University of Richmond in June 1954 and is now working towards the doctorate at the University of Michigan.

Charles M. Lankford, Jr., Commissioner of Fisheries of Virginia, was unanimously elected Chairman of the Atlantic States Marine Fisheries Commission for the coming year at their meeting held at Baltimore. The Commission has a membership of fifteen Atlantic Coast states and meets annually to coordinate the fisheries research programs and to discuss legislation and other matters concerning the fisheries. The Commission was organized in 1942.

The College of William and Mary was recently host to the Atlantic Estuarine Research Society. Members of the Society, brought together by a common interest in the physics, chemistry, and biology of estuaries

such as Chesapeake and Delaware bays, meet twice yearly to discuss research projects.

The family of the late Professor W. D. Hoyt of Washington and Lee has given the Department of Biology an excellent research microscope in memory of Professor Hoyt.

Mr. John E. Davis, Jr. has returned to the Biology Department of Washington and Lee as instructor in Biology. Mr. Davis attended Mountain Lake Biological Laboratory during the summer of 1954 where he was engaged in research leading toward the doctorate at the University of Virginia.

Mr. Bertram B. Hanna joined the faculty of the Medical College of Virginia in September 1954 as an A. D. Williams fellow in the Department of Biology and Genetics. Mr. Hanna's research interests are population and medical genetics.

The Mountain Lake Biological Station of the University of Virginia celebrated its Silver Anniversary on July 17, 1954. The formal celebration was preceded by a social gathering at the Mountain Lake Hotel and open house at the Station. Professor Bruce D. Reynolds, Director of the Station presided at the formal program. The Invocation was given by the Reverend Ellison Smyth of Blacksburg, Virginia. Ivey F. Lewis, Dean of the College of Arts and Sciences, University of Virginia and formerly Director of the Station (retired), traced the history of the Station from its beginnings in the Thompson Cottage on the hotel grounds to the present modern stone laboratory. The principal address was delivered by Mr. C. E. Sunderlin, Deputy Director of the National Science Foundation, who spoke on the "*Sineus of Science*". This address is the lead article in the present number of this Journal. The Benediction was pronounced by the Reverend Daniel B. Suter of Eastern Mennonite College. The celebration was attended by many distinguished guests and former students of the Mountain Lake Biological Station.

ROBERT T. BRUMFIELD, *Longwood College*

#### CHEMISTRY SECTION

Dr. Eugene D. Crittenden, Director of Research, Nitrogen Division, Allied Chemical and Dye Corporation, has been named by the Virginia Section of the American Chemical Society as the recipient of its Distinguished Service Award, which is given annually for outstanding contributions to the professional standing of chemists.

Herbert Felix Sanders, Director of Science for the Martinsville School Division, was also selected by the Virginia Section to receive its second Distinguished Service Award, which is given for excellence in science teaching in the secondary schools of Virginia. These awards are made possible each year by a gift from Mrs. Henry K. McConnell of Richmond in memory of her husband, who was a former chairman of the Section and a recognized leader in industrial chemistry in the South.

A number of Virginia chemists presented papers at the September meeting of the American Chemical Society held in New York. Dr. Frank A.



Vingiello, with Alexej Borkovec and Joseph Shulman, Virginia Polytechnic Institute, discussed "The Synthesis of 10-Phenyl-1,2-benzanthracene and the Three Isomeric 10-Monomethyl-1,2-benzanthracenes." Dr. William P. Boyer, Director of Research, Virginia-Carolina Chemical Corporation, served as chairman of a symposium on "Resources for the Chemical Industry in the South Atlantic States" in which three other Virginians participated: Allan T. Gwathmey, University of Virginia, spoke on "Research and Educational Resources of the South Atlantic States"; Edward A. Wayne, First Vice-President of the Federal Reserve Bank of Richmond, presented "Financial Resources of the South Atlantic States"; Edwin Cox, Vice-President of the Virginia-Carolina Chemical Corporation, discussed "Chemical Industry in the South Atlantic States". Mr. Cox was also luncheon speaker for the American Chemical Society Division of Fertilizer and Soil Chemistry. His topic was "Plant Food Research — Evolution or Revolution". Herschel S. Jenkins, also a Virginia-Carolina Chemical Corporation staff member, read a paper on "Proteins as Fiber-Forming Materials", and Henry Leidheiser and Victor J. Kehler, members of the Virginia Institute for Scientific Research, discussed the "Catalytic Decomposition of Carbon Monoxide on Large Metallic Single Crystals. James E. Worsham, Jr., with H. A. Levy and S. W. Peterson of the Oak Ridge National Laboratory, presented a paper on "Neutron Diffraction Investigation of the Positions of Hydrogen Atoms in Urea Crystals". Dr. Worsham has recently joined the staff at the University of Richmond, transferring from Hampden-Sydney College. Dr. J. Stanton Pierce and A. G. Richardson of the University of Richmond gave a paper on the subject of "Tetrazolium Salts". Representing the University of Virginia, in addition to Dr. Gwathmey, were Dr. Alfred Burger, who with A. Chandler Schmalz presented a paper on "The Action of Hydrochloric and Nitric Acid on Some Derivatives of Phenothiazine", Robert J. Gibbs and Alfred Chanutin, who discussed the "Denaturation of Human Plasma Albumin with Reference to pH and Ionic Strength", and Dr. Robert E. Lutz and W. Bruce Black, whose paper was entitled "Ultraviolet Absorption Spectra of Chalcones — Partial Chromophores". Dr. Burger also gave the Paul Ehrlich Centenary Memorial Lecture before the Division of Medicinal Chemistry. His talk was reprinted in the October 18 issue of *Chemical and Engineering News*.

Additional publications which have been reported are the following: From Randolph-Macon Woman's College, Julia T. Gary and Lucy W. Pickett, "The Far Ultraviolet Absorption Spectra of the Isomeric Butenes" in *J. Chem. Phys.*, 22, 599 (1954); also by the same authors a similar paper on isomeric hexenes, *ibid.*, p. 1226. From Virginia Polytechnic Institute, Philip C. Scherer and Norbert J. Crookston, "Solvation of Cellulose Nitrate in Acetone-Water", *J. Polymer Sci.*, 14, 129 (1954); John W. Murray, "The Decomposition of Calcite and Aragonite in Caves", *J. Geol.*, 62 (1954); Robert C. Krug and P. J. C. Tang, "The Preparation of Diakyl zinc Compounds", *J. Am. Chem. Soc.*, 76, 2262 (1954). From the Medical College of Virginia, C. C. Clayton and J. D. Spain, "Reticulo-Endothelial System and Azo Dye Carcinogenesis", *Fed. Proc.*, 13, 193 (1954); J. C. Forbes, J. A. Board, and G. M. Duncan, "Adrenal Response of Rats



to Salicylamide and Sodium Salicylate With and Without Para-Aminobenzoic Acid", *Proc. Soc. Exp. Biol. and Med.*, 85, 37 (1954); J. C. Forbes, P. D. Camp, W. R. Jordan, O. M. Petterson, and C. Korn, "Serum Cholesterol Fractionation Studies", *Sou. Med. J.*, 47, 226 (1954). Also G. W. James, L. D. Abbott, J. W. Brooks, and E. I. Evans, "The Anemia of Thermal Injury, III—Erythropoiesis and Hemoglobin Metabolism Studied with  $N^{15}$ -Glycine in Dog and Man", *J. Clin. Inv.*, 33, 150 (1954); G. W. James and L. D. Abbott, "Erythrocyte Destruction in Sickle Cell Anemia: Simultaneous  $N^{15}$ -Hemin and  $N^{15}$ -Stereobilin Studies", *Clin. Res. Proc.*, 2, 57, (1954); L. D. Abbott and M. J. Dodson, "Inhibition of *In Vitro* Heme Synthesis From  $N^{15}$ -Glycine by 2-Ethyl-5-Methylbenzimidazole", *Proc. Soc. Exp. Biol. and Med.*, 86, 475 (1954).

On the academic front a number of staff changes have occurred. At Hampden-Sydney College Dr. James M. Frederickson, formerly at Davis-Elkins College, has replaced Dr. T. H. Pearson as Head of the Chemistry Department. Dr. Pearson is now associated with the Ethyl Corporation in Louisiana. Charles W. Bondurant has also rejoined the Hampden-Sydney staff after a year of graduate study at Virginia Polytechnic Institute. A newcomer to the Biochemistry Department of the Medical College of Virginia is Dr. Richard L. Hardin. Dr. Hardin received his Doctor's degree from the University of Wisconsin and taught formerly at the University of Louisville Medical School. From Randolph-Macon Women's College: Miss Helen V. Pashko, Instructor in Chemistry, has resigned to accept a position with Olin Industries in New Haven, Connecticut. Dr. Laura Bliss, Assistant Professor of Chemistry, has been granted a leave of absence and will study at Cambridge University in England this year. Her teaching duties will be taken over by Miss Julia T. Gary, who has joined the staff as an Instructor in Chemistry. Miss Gary is an alumna of Randolph-Macon and received her Master's degree from Mount Holyoke. She taught at Mount Holyoke last year and was engaged in research there. Miss Gloria Sober, A.B. from the University of Pittsburgh, was also appointed as Instructor in Chemistry. Miss Sober has completed her work for her Master's degree at Pittsburgh and will receive the degree in February. Dr. Nan V. Thornton, Chairman of the Chemistry Department, has returned from a leave of absence which she spent doing research at the University of Chicago.

From Roanoke College Dr. Ashley Robey reports that Mrs. Leroy (Norma B.) Moran has been added to the staff as an Instructor in Chemistry. Mrs. Moran received her B.S. degree from Lynchburg College and her M.S. degree from the University of Tennessee. Dr. Thomas C. Franklin, formerly at the University of Richmond, is now an Assistant Professor of Chemistry at Baylor University. His replacement, as noted previously, is Dr. James E. Worsham, Jr. Dr. Worsham holds a B.S. from Richmond, a M.S. from Vanderbilt University, and a Ph.D. from Duke University. A recent addition to the staff at the University of Virginia is Dr. Loren G. Hepler, who will serve as an Assistant Professor. Dr. Hepler received his Ph.D. in Physical Chemistry from the University of California and has been working as a postdoctoral fellow at the University of Minnesota. Dr.

Nicholas Cabrera has been made Professor of Chemistry and Physics at Virginia. He was formerly an Associate Professor of Physics, but will now offer a course in quantum mechanics for chemists in alternate years. Dr. Ralph E. Thiers, Assistant Professor on leave of absence, is continuing his work in the Biophysics Research Laboratory at the Peter Bent Brigham Hospital in Boston.

At Virginia Polytechnic Institute Dr. Russell E. Leed, who has been on official leave with the Atomic Energy Commission, has resigned his position as Associate Professor to accept a permanent appointment with the Atomic Energy Commission at Oak Ridge, Tenn. Edward C. Kramer, Instructor in Chemistry, has transferred to Clemson College. Dr. Ralph G. Steinhardt has joined the staff as an Associate Professor of Chemistry. He was formerly an Assistant Professor at Lehigh University, from which he received his B.S., M.S., and Ph.D. degrees. He also holds a B.S. degree in Chemical Engineering from Virginia Polytechnic Institute. Dr. Luther K. Brice has also been added to the Chemistry staff as an Assistant Professor. Dr. Brice has a B.A. degree from Harvard University, a M.A. from Dartmouth College, and has just completed requirements for his Ph.D. at Duke University. His specialty is physical chemistry.

Among the changes in personnel taking place on the industrial scene the following have been reported by the Virginia-Carolina Chemical Corporation, Richmond. Dr. J. Samuel Gillespie, Jr., former Group Leader with the Fiber Research Unit, has been transferred to the Fiber Division in New York. Charles L. Harowitz has been promoted to Group Leader of Organic Research in Richmond. Paul H. Coffey and Taylor G. King, both of the University of Richmond, have been added to the research staff, the former with the Organic Research Group and the latter with the Fiber Unit. John M. Daniel, who received his bachelor's degree from the University of Virginia and his master's degree from the Georgia Institute of Technology, has joined the chemical engineering staff, and Leslie H. Jenkins has been appointed Senior Chemist with the Inorganic Division. Jenkins received both his bachelor's and doctorate from the University of North Carolina. Dr. John P. Horton has been added to the Development Department. He is a graduate of the Massachusetts Institute of Technology and was formerly associated with the National Dairies Research Laboratories.

Concurrently with a physical expansion in their research facilities a number of additions to the research staff have been announced by the American Tobacco Company in Richmond. These include Miss Barbara Anne Eanes, B.S. Mary Washington College, as Analytical Chemist; Mrs. Darien Dorn Mahaffee, B.A. Lander College and M.S. University of South Carolina; and J. Scott Osborne, M.S. Wake Forest College, both as Research Chemists; as Research Biochemist, Burton M. Pogell, B.A. Johns Hopkins University and Ph.D. University of Wisconsin. Also added to the staff as Research Biochemist is Dr. William A. Peabody. Dr. Peabody holds a degree in Chemical Engineering from the Colorado School of Mines and a M.S. and Ph.D. from the University of Colorado. He



was formerly associated with the Valentine Meat Juice Company in Richmond.

An addition to the building of the American Tobacco Company Research Laboratory is now being constructed and is expected to be completed by the end of January 1955. The new addition will double approximately the present laboratory space, and on completion will be used to house the research departments. Control work will be coordinated entirely within the present building. The new quarters have been carefully planned to provide the most modern facilities and equipment needed for the Laboratory's work. Research on tobacco and tobacco smoke will be facilitated by the latest analytical methods, including mass spectrometry and emission spectrography. Equipment for radiological studies will also be available. The Company is also financing through a grant of 120,000 dollars the construction of a greenhouse at the Medical College of Virginia, which will be used for growing radioactive tobacco. The structure will consist of an ordinary greenhouse with a smaller sealed chamber for growing radioactive plants. Tobacco uniformly labelled with  $C^{14}$  will be obtained by growing the tobacco plants in an atmosphere containing the radioactive isotope Carbon 14 as carbon dioxide. The whole plant or individual compounds will then be used in the biological research program sponsored by the American Tobacco Company at the Medical College of Virginia and also in the chemical and physical studies of tobacco and tobacco smoke conducted in its own laboratory. The greenhouse will be one of the few in this country with facilities for growing radioactive plants.

Some other items of interest. Herschel S. Jenkins, Section Leader of Virginia-Carolina's Fiber Research Section participated in the Fourth Canadian Textile Seminar at Queen's University, Kingston, Ontario in September. His paper, "Textile Fibers From Proteins", has been published in "The Book of Papers of the Fourth Canadian Textile Seminar of the Textile Technical Federation of Canada".

The Virginia-Carolina Chemical Corporation is continuing its fellowships at the University of Virginia for research on organic-phosphorus compounds under the direction of Dr. Alfred Burger. The Company also sponsors fellowships for graduate study on pesticides at Cornell, Rutgers, and Louisiana State University.

The Army Ordnance Works is sponsoring two projects at Virginia Polytechnic Institute under the direction of Dr. Philip C. Scherer and one under the supervision of Dr. Frank A. Vingiello. The Air Force Commission is sponsoring a project under Dr. Robert C. Krug. Dr. F. B. Clough, Assistant Professor of Chemistry at Virginia Polytechnic Institute served as a Research Participant at Oak Ridge during the summer.

Miss Imogene Claiborne, Assistant in Chemistry at Randolph-Macon Women's College, received a Grant-In-Aid from Duke University for study during the summer months.

Dr. James E. Worsham, University of Richmond, has been awarded a grant from the Research Corporation for the study of dipole moments of organic compounds, and Miss Velta Erdmanis, a graduate of the Uni-



versity of Richmond, has been awarded a research assistantship made available by the same agency. Mr. James W. Cook has been awarded a Pur-year fellowship for graduate study in chemistry.

From the University of Virginia: A copy of a Technical Report entitled "Survey of the Literature on Antioxdants and Anticorrosion Additives for Lubricants at Elevated Temperatures" by Drs. A. F. Benton, Alfred Burger, and J. W. Cole has been presented to the Chemistry Library. This report results from an Air Force Project which is entering its fourth year. Dr. J. W. Cole is the Principal Investigator. Dr. Cole is also serving as Consultant on the Advisory Panel for the Division of Scientific Personnel and Education of the National Science Foundation. Last year he was a member of the Fellowship Screening Panel of the National Research Council. Dr. Allan T. Gwathmey of the University faculty was invited to present a paper in Paris to the Soci  t   de Chimie Physique but was not able to make the trip. In his absence a paper by Drs. Gwathmey and R. E. Cunningham was read before the Society for the authors by Mme. Adrienne Weill. Madam Weill, who was a pupil of Marie Curie, spent several days at the University last year and gave two lectures on Marie Curie and on the discovery of radium to the General Chemistry Class.

Dr. John H. Yoe, Chairman of the Chemistry Department of the University of Virginia, Dr. A. T. Gwathmey, and Dr. Bruce Wagner attended the Gordon Conference last August. Dr. Wagner will attend the Massachusetts Institute of Technology next year as a postdoctoral fellow, working with Dr. Carl Wagner. As a guest of the General Electric Company Dr. Yoe also visited prior to the American Chemical Society Meeting in New York the research laboratories and industrial plants of the General Electric Company in the Schenectady area. At the American Chemical Society Meeting he was elected to the Council Policy Committee for a term of three years, beginning the first of January. Dr. Robert E. Lutz and Dr. James W. Cole will present papers at the American Chemical Society Southeastern Regional Meeting which meets in Birmingham in October.

Dr. E. S. Gilreath, Associate Professor of Chemistry at Washington and Lee University is the author of a text entitled "Qualitative Analysis Using Semimicro Methods" published in September by McGraw-Hill. Dr. John H. Wise, also of the Washington and Lee staff held an appointment at Oak Ridge during the summer. He was engaged in work on high-resolution spectroscopy.

A conference on "Undergraduate Research in Chemistry", sponsored by the National Science Foundation, was held at Washington and Lee last May. Dr. L. J. Desha, Head of the Chemistry Department, served as Chairman of the Planning Committee and as the Washington and Lee Representative. Thirty-two colleges and universities selected from all parts of the country participated in the conference. The College of William and Mary, with Dr. William G. Guy, Head of the Chemistry Department, as its representative, was the only other Virginia school represented at the Conference. Teachers who are interested in the problems of undergrad-

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uate research will certainly find the Report of the Conference to be stimulating and worthwhile reading.

CARL J. LIKES, *Virginia Institute for Scientific Research*

#### ENGINEERING SECTION

After 19 years as head of the Chemical Engineering Department at Virginia Polytechnic Institute, Dr. Frank C. Vilbrandt has relinquished this administrative position to Dr. Fred W. Bull who has been on the faculty there since 1938. Dr. Vilbrandt will continue to serve as Professor of Chemical Engineering.

Dr. Fred Bull attended the seminar on teaching methods held by the General Electric Company in Schenectady, New York from August 30 to September 4.

Dr. Dale S. Davis of the Chemical Engineering Department of Virginia Polytechnic Institute is the contributor of a section entitled "Nomography" in the Chemical Business Handbook recently published by McGraw-Hill.

Dr. Nelson F. Murphy of the Chemical Engineering Department at Virginia Polytechnic Institute addressed the New York Section of the American Electroplaters' Society in Syracuse, New York on September 17.

In August, Dean John W. Whittemore of Virginia Polytechnic Institute and Drs. Fred Bull and P. H. Watkins from the Chemical Engineering Department attended the meeting of the south central group of the National Council for Stream Improvement held in Lynchburg.

Dean Whittemore also attended a meeting held in Minneapolis, Minnesota of the National Council of State Boards for Engineering Examiners as representative of the National Institute of Ceramic Engineers.

Dr. Lawrence R. Quarles, Assistant Dean of the School of Engineering of the University of Virginia, has been relieved temporarily of part of his teaching duties in order to serve as consultant to the Oak Ridge National Laboratory on problems involving control of the homogeneous reactor.

Dr. Otis L. Updike, Jr., of the Chemical Engineering Department of the University of Virginia is on leave of absence for the session of 1954-1955 and is employed by the Naval Air Missile Testing Center at Point Mugu, California. He is obtaining valuable experience in the design and construction of electrical computers and their use in solving engineering problems.

Dr. Robert M. Hubbard of the Chemical Engineering Department of the University of Virginia attended the American Institute of Chemical Engineers First International Nuclear Energy Congress in Ann Arbor, Michigan in June.

Mr. Tilton E. Shelburne and Mr. Phillip Melville of the Virginia Council for Highway Investigation and Research at the University of Virginia, and Mr. Alfred Manor of the Virginia Department of Highways attended the Annual Highway Conference at the Virginia Military Institute in October. Mr. Melville presented a paper on "Quality Concrete." Mr. Phillip



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Melville spent the months of June and July in Europe and visited England, France, and Italy during that time.

ROBERT M. HUBBARD, *University of Virginia*

#### GEOLOGY SECTION

Of much interest to all members of the Geology Section was the publication in October, 1954 of the first issue of *Virginia Minerals*, the new quarterly of the Virginia Division of Geology. Upon request, the Division of Geology will be happy to put your name on its mailing list to receive future copies of *Virginia Minerals*. The new publication is designed to acquaint the public with the mineral resources of Virginia and to provide geologic information leading to their exploration.

"Geology and Oil Possibilities of the Rose Hill District, Lee County, Virginia" by Ralph L. Miller and J. Osborn Fuller is slated to appear soon as Bulletin 71 of the Virginia Division of Geology.

The Geology Department of Washington and Lee University is forming a collection of specimens of minerals and rocks representing radioactive deposits throughout the United States. Radioactive specimens collected to date represent about 35 eastern and 20 western localities. Radiometric instruments in the Department consist of a Precision Model III Scintillator, an El-Tronics Model SM-3 Geiger counter, a Mineral Engineering Co. Model 600-A Geiger counter for making radiometric assays, a Tracerlab Model SU-7 Geiger counter, and long-wave and short-wave ultraviolet Mineralights.

Titanium-bearing ores in the Vinton-Stewartsville area of Virginia were investigated during August 1954, by C. E. Sears of the Virginia Polytechnic Institute Geology Department. The Bush-Hutchins lead near Vinton was extended about a quarter of a mile to the southwest. An investigation was also made of a 20-foot outcrop of what appears to be a high-grade titaniferous ore on the Mcleod farm southeast of Stewartsville. Further investigation of these deposits using magnetic equipment to supplement surface geology is planned in the near future.

Dr. Jean Lowry, geologist of the Virginia Division of Geology, spoke on *Caves of Virginia* at a meeting of the Holden Society of Virginia Polytechnic Institute on September 21, 1954. Her talk was illustrated by numerous kodachrome slides showing many interesting cave formations.

"The Deposition of Calcite and Aragonite in Caves" by Dr. John W. Murray, professor of Chemistry, Virginia Polytechnic Institute appeared in the September 1954 issue of *The Journal of Geology*.

During the past summer Wayne E. Moore of the Virginia Polytechnic Institute Geology Department began a study of the sands associated with the coastal terraces of Virginia. The relationship of coastal geomorphology to the properties of the sands is being investigated.

The sedimentation tank at the Virginia Polytechnic Institute has been fitted with a wave-maker that can generate waves of three different amplitudes at each of three different frequencies. The tank and wave apparatus are being used to study sedimentation processes of rivers and coasts.

W. D. LOWRY, *Virginia Polytechnic Institute*

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## PSYCHOLOGY SECTION

A large number of Virginia psychologists attended the annual meetings of the American Psychological Association in New York, September 1-8. William M. Hinton and Stanley B. Williams were delegates from Virginia at the workshop on legislation sponsored by the Conference of State Psychological Associations. Mr. Hinton also represented Virginia at the two meetings of the State Board of Examiners. Frank W. Finger was chairman of a symposium, New Courses in Introductory Psychology, sponsored by the Division on the Teaching of Psychology. L. Starling Reid chaired a symposium, The Place of the Concept of Drive in Motivation Theory, sponsored by the Division of General Psychology. Richard H. Henneman presented a paper on the program of the Division of Military Psychologists. Frank A. Geldard is president-elect of the Division of Experimental Psychology. Frank W. Finger is chairman of the Committee on Undergraduate Education of the Education and Training Board of the American Psychological Association.

During the New York meetings of the American Psychological Association, there was held an organization meeting of a new regional psychological association representing the states below the Mason-Dixon Line and east of the Mississippi River. The new association will be known as the Southeastern Psychological Association. Virginia psychologists have been invited to affiliate with this association.

Officers of the Richmond Psychological Association for 1954-55 are: Dr. Cyril Mill, Richmond Public Schools, president; Dr. Robert Filer, University of Richmond, vice-president; and Dr. Jacob Silverberg, McGuire Veterans Hospital, secretary-treasurer.

Several personnel changes have occurred in the Psychology Department at the University of Virginia. Frank W. Finger has returned after a year's leave of absence at Yale on a Ford Foundation Fellowship. Kenneth E. Lloyd, a recent Ph.D. from Ohio State University, has been appointed assistant professor of psychology. Raymond E. Bice has been appointed director of admissions at the University. Evan G. Pattishall has been appointed assistant professor of educational research in the School of Education. Richard H. Henneman was promoted from associate professor to professor of psychology, and L. Starling Reid, from assistant professor to associate professor of psychology.

Miss Marjorie Brownell is on leave of absence from Randolph-Macon Woman's College to do advanced graduate work at the University of Massachusetts. Mr. Paul Mountjoy, of the University of Indiana, is filling her place in the department.

RICHARD H. HENNEMAN, *University of Virginia*

## SCIENCE TEACHERS SECTION

A conference on Biology Teaching, sponsored by the National Association of Biology Teachers in cooperation with the American Institute of

Biological Sciences and made possible by a grant from the National Science Foundation, was held in Gainesville, Florida, during the latter part of August and early September.

Approximately 100 persons — including research biologists, high school and college teachers of biology, and professional educators — from 17 states, the District of Columbia, and the Canal Zone were invited and participated in the discussions.

Representatives were also present from the American Association for the Advancement of Science, the National Research Council, and the National Science Foundation.

The Conference was under the direction of Dr. Richard Weaver of the University of Michigan, and Mr. George Jeffers of Longwood College, Mr. Samuel L. Meyer of Florida State University, Mr. Ned Bingham of the University of Florida, and Mr. Hugh Stickler of Florida State University served as staff members.

Delegates from Virginia were Miss Samuella Crim of Broadway High School, Miss Susie V. Floyd of Newport News High School, Mr. Horton H. Hobbs of the University of Virginia, Mr. Jeffers, Mr. Charles E. Packard of Randolph-Macon, Ashland, Mr. J. V. Parnell of Virginia State College, and Mr. Percy H. Warren of Madison College.

CAROLINE GAMBRILL, *Waynesboro*

#### STATISTICS SECTION

Dr. D. B. Duncan has resigned his position as professor of statistics at the Virginia Polytechnic Institute effective December 31, 1954, and has accepted a position as professor and statistical

consultant at the University of Florida in Gainesville.

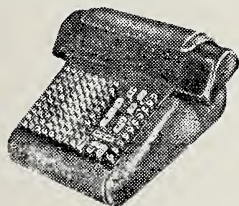
Dr. R. A. Bradley has been granted a leave of absence from the Virginia Polytechnic Institute from February 1 to May 31. During this period, he will be a visiting professor in the Department of Mathematics and Applied Statistics at Rutgers University.

Dr. John E. Freund, who has been a visiting professor at the Virginia Polytechnic Institute since September of 1954 and on leave of absence from Alfred University, has resigned his position at Alfred in order to accept a permanent position at the Virginia Polytechnic Institute.

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The following members of the Statistics Department of the Virginia Polytechnic Institute attended and presented papers at the joint session at Montreal, Canada, September 10-13: Dr. Boyd Harshbarger, "2<sup>3</sup> Factorial in a Latinized Rectangular Lattice Design"; Dr. George L. Edgett, "Multiple Regression with Missing Observations Among the Independent Variables"; Dr. Ralph A. Bradley, "A Note on the T-Distribution for Samples from a Bi-Modal Population and a Skew Population"; Dr. William A. Thompson, "A Topic in Variance Components Analysis"; Dr. Paul N. Somerville, "Optimum Sampling in Multinomial Populations"; Dr. David B. Duncan, "Simultaneous Confidence Intervals Derived from Multiple Range and Multiple F. Tests"; Mr. Hale S. Sweeny, "Analysis of Experiments with Correlated Observations and Heterogeneous Variances"; Dr. John E. Freund, and Mr. Thomas S. Russell.

Dr. William A. Thompson, associate professor of statistics at the Virginia Polytechnic Institute and principal investigator of a contract sponsored by the Quartermaster Corps of the United States Army, received a Doctor of Philosophy degree in Statistics from the University of North Carolina in August 1954.

Dr. William E. Cook has resigned his position at the Richmond Professional Institute and has accepted a position with Alton State Hospital, Alton, Illinois.

The following are recent publications of members of the Department of Statistics of the Virginia Polytechnic Institute: "Statistical Methods Applied to Highway Research Experimentation", by D. B. Duncan, *Proc. Highway Research Board*, 33, 1954; "Multiple Range and Multiple F Tests", by D. B. Duncan, *Biometrics*, II, 1955; "Rank Analysis of Incomplete Block Designs, Additional Tables for the Method of Paired Comparisons," by R. A. Bradley, *Biometrika*, 41, 319, December 1954; "Incomplete Block Rank Analysis: On the Appropriateness of the Model for a Method of Paired Comparisons", by R. A. Bradley, *Biometrics*, 10, 375, September 1954; "A 2 x 2 Factorial with Paired Comparisons", by R. A. Bradley and R. M. Abelson, *Biometrics*, 10, December 1954; "Some Problems of Optimum Sampling", by P. N. Somerville, *Biometrika*, December 1954, Parts 3 and 4, Vol. 41.

LIONEL WEISS, *University of Virginia*







THE ANNUAL SUBSCRIPTION rate is \$3.00, and the cost of a single number, \$1.00. Reprints are available only if ordered when galley proof is returned. All orders except those involving exchanges should be addressed to Boyd Harshbarger, Virginia Polytechnic Institute, Blacksburg, Virginia. The University of Virginia Library has exclusive exchange arrangements, and communications relative to exchange should be addressed to The Librarian, Alderman Library, University of Virginia, Charlottesville, Virginia.

### NOTICE TO CONTRIBUTORS

Contributions to the Journal should be addressed to Horton H. Hobbs, Jr., Miller School of Biology, University of Virginia, Charlottesville, Virginia. If any preliminary notes have been published on the subject which is submitted to the editors, a statement to that effect must accompany the manuscript.

Manuscripts must be submitted in triplicate, typewritten in double spacing on standard  $8\frac{1}{2}$ " x 11" paper, with at least a one inch margin on all sides. Manuscripts are limited to seven pages, with the proviso that if additional pages are desired, the author may obtain them at cost.

Division of the manuscript into subheadings must follow a consistent plan, and be held to a minimum. It is desirable that a brief summary be included in all manuscripts.

Footnotes should be included in the body of the manuscript immediately following the reference, and set off by a dashed-line above and below the footnote content. Footnotes should be numbered consecutively from the beginning to the end of the manuscript.

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## Inhibition of *in vitro* Heme Synthesis from N<sup>15</sup>-Glycine by 2,5-Dimethylbenzimidazole, 5,6-Dimethylbenzimidazole and Related Compounds<sup>1</sup>

LYNN D. ABBOTT, JR. AND MARY J. DODSON

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5,6-Dimethylbenzimidazole is a part of the vitamin B<sub>12</sub> molecule. Emerson and associates (1950) studied the vitamin B<sub>12</sub>-like activity of this and related compounds when fed to rats on diets devoid of animal protein and containing thyroid powder. They noted that, unlike 5,6-dimethylbenzimidazole which had vitamin B<sub>12</sub>-like growth activity, 2,5-dimethylbenzimidazole appeared to act as a growth depressant. This property was not exhibited by benzimidazole itself or by any of the other mono- or dimethylbenzimidazoles studied. They remarked that 2,5-dimethylbenzimidazole might have "inhibitor activity". Because of the chemical relationship of 2,5-dimethylbenzimidazole to the benzimidazole moiety of vitamin B<sub>12</sub> and to the purines, we have investigated its effect on the *in vitro* synthesis of heme by chicken erythrocytes.

The present studies indicate that 2,5-dimethylbenzimidazole is a potent inhibitor of the utilization of glycine for heme synthesis in chicken erythrocytes incubated *in vitro*. Investigation of related compounds indicated that benzimidazole, the 2-methyl- and the 5-methylbenzimidazole had some, but not comparable, inhibitory effects in this system. Since the 5-methyl derivative appeared to be somewhat more effective, 5,6-dimethylbenzimidazole was investigated and found to be equally as effective as 2,5-dimethylbenzimidazole. 2-Ethyl-5-methylbenzimidazole was found to be the most effective inhibitor of all. The chemical relationship of these compounds to each other, and to vitamin B<sub>12</sub> and the purines, is illustrated in Figure 1.

### EXPERIMENTAL

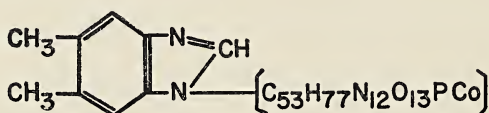
The nucleated erythrocytes of avian blood have been shown to incorporate N<sup>15</sup> from labeled glycine into the protoporphyrin of hemoglobin which

<sup>1</sup> Presented at the 32nd annual meeting of the Virginia Academy of Science, Charlottesville, May 7, 1954. This paper was awarded the J. Shelton Horsley Research Award for 1954 and appears at the request of the Editors of the Virginia Journal of Science. Studies with the methyl-substituted benzimidazoles were published in the Journal of Biological Chemistry [211 (845), December, 1954], and those with 2-ethyl-5-methylbenzimidazole appeared in the Proceedings of the Society for Experimental Biology and Medicine [86 (475), July, 1954].

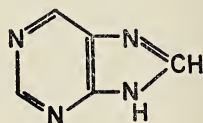
\* Paper received November 15, 1954.

can be isolated as  $N^{15}$ -labeled hemin after incubation of duck blood with  $N^{15}$ -glycine (Shemin et al., 1948, 1950).

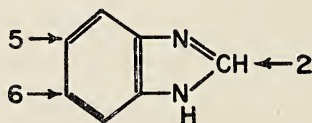
In the present experiments we have used chicken blood in this way as an *in vitro* biological test system for the study of hemoglobin synthesis. Twenty ml. blood samples were incubated with the experimental compound and 25 mg. glycine containing 31 atom per cent  $N^{15}$  (Schoenheimer et al., 1939) in 50 ml. Erlenmeyer flasks with constant shaking for 24 hours in a water bath at  $37^{\circ}\text{C}$ . In each experiment the effect on heme synthesis of the substance studied was determined by comparison with a control sample of the same blood incubated with  $N^{15}$ -glycine only at the same time under identical conditions. Hemin was isolated as described by Shemin and Rittenberg (1946) and recrystallized according to Fischer (1941). Hemin from each blood sample was analyzed for  $N^{15}$  content in a mass spectrometer. Each of duplicate samples was compared with tank nitrogen as a reference standard and the  $N^{15}$  atom per cent excess over tank nitrogen determined.



VITAMIN B<sub>12</sub>



PURINE



BENZIMIDAZOLE

2-METHYL—

5-METHYL—

2,5-DIMETHYL—

5,6-DIMETHYL—

2-ETHYL-5-METHYL—

FIGURE I.—Benzimidazole derivatives studied and their relationship to the vitamin B<sub>12</sub> and purine structures.

## RESULTS

In our previous studies it was determined that the  $N^{15}$  concentration of isolated hemin was the same in the test and control samples if a supple-

mentary compound did not affect the incorporation of  $N^{15}$  from  $N^{15}$ -glycine into heme (Abbott et al., 1952). In the present experiments, however, a progressive decrease in hemin  $N^{15}$  content was noted with increasing amounts of 2,5-dimethylbenzimidazole (Table I). In the presence of 10 mg. (.003M) 2,5-dimethylbenzimidazole (Exps. 2,3,4) the incorporation of  $N^{15}$  was decreased considerably, whereas with 15 mg. (.005M) blocking of isotope incorporation was almost complete (Exps. 5,6). Inhibition was slight with 5 mg. (Exp. 1) but complete with 20 mg. (Exps. 7,8). Addition of vitamin  $B_{12}$ , either 15  $\mu$ g. or 100  $\mu$ g. (Exps. 3,5), or of 25 mg. folic acid (Exp. 6), did not alter the effect of 2,5-dimethylbenzimidazole; the  $N^{15}$  content of the hemin was the same as with 2,5-dimethylbenzimidazole alone. In Exp. 7 complete inhibition by 20 mg. 2,5-dimethylbenzimidazole was compared with the lesser effect of 20 mg. adenine. Exps. 9, 12 and 15 show that 15 mg. benzimidazole had some inhibitory effect which was not comparable to that obtained with the same amount of the 2,5-dimethyl derivative. The lesser effect of 20 mg. of benzimidazole compared with 20 mg. of the 2,5-dimethyl derivative is seen in Exp. 8. Similarly, 2-methylbenzimidazole (Exps. 10, 11 and 12) had a slight effect which was comparable to that of benzimidazole (Exp. 12). That this effect was real however, is indicated in Exp. 11 in which an additional flask incubated with 15 mg. orotic acid showed no difference from the control sample. The 5-methyl derivative (Exp. 13) had a greater effect than either benzimidazole or the 2-methyl derivative (Exp. 12) although not so great as that with the same amount of 2,5-dimethylbenzimidazole (Exps. 5,6). This suggested the importance of the 5 position and 5,6-dimethylbenzimidazole was obtained from Dr. Karl Folkers and studied. It was found to be equally as effective as 2,5-dimethylbenzimidazole in blocking incorporation of isotope into heme (Exps. 14-17). Inhibition was almost complete with 15 mg. and complete with 20 mg. (Exps. 16,17). The formic acid salt of 5,6-dimethylbenzimidazole and the free base were both inhibitory (Exps. 14-17).

Experiments 18-21 show that 2-ethyl-5-methylbenzimidazole was considerably more inhibitory than 2,5-dimethylbenzimidazole. Thus 5 mg. (.0017M), which produced minimal (18%) inhibition with 2,5-dimethylbenzimidazole, gave marked (67%) inhibition with the 2-ethyl-5-methyl derivative (Exp. 18). Ten mg. 2-ethyl-5-methylbenzimidazole (.003 M) gave complete inhibition whereas this required 20 mg. 2,5-dimethylbenzimidazole (Exps. 19 and 20). Two mg. 2-ethyl-5-methylbenzimidazole (.0006 M) produced approximately the same degree of inhibition as 20 mg. benzimidazole (.0085 M). Thus 2-ethyl-5-methylbenzimidazole was as effective as 14 times the concentration of benzimidazole, and at the .0016 M level the percentage decrease in  $N^{15}$  uptake from the control experiment was about 4 times greater with the 2-ethyl-5-methyl derivative than with 2,5-dimethylbenzimidazole. Complete inhibition occurred with half the amount required by 2,5-dimethylbenzimidazole.



## DISCUSSION

It is apparent that 2,5-dimethylbenzimidazole, 5,6-dimethylbenzimidazole, and 2-ethyl-5-methylbenzimidazole prevent the incorporation of  $N^{15}$  from  $N^{15}$ -glycine into heme by chicken erythrocytes when incubated *in vitro* as described. These were more effective than adenine and at concentrations much lower than we found previously with sodium fluoride (Abbott et al., 1952). A slight, but not comparable, effect was exhibited by benzimidazole and the 2-methyl derivative, and 5-methylbenzimidazole had an effect intermediate between that of benzimidazole and 2,5-dimethylbenzimidazole. Substitution of a methyl group in the 5 position apparently increased the inhibitory effect of benzimidazole; this was enhanced markedly by further methyl substitution in the 2 or 6 positions, and to an even greater extent by substitution of an ethyl group in the 2 position.

The mechanism whereby these compounds interfere with the introduction of  $N^{15}$  from glycine into heme during *in vitro* incubation of chicken erythrocytes is not known. In previous studies we found inhibition to occur with certain enzyme inhibitors such as fluoride (Abbott et al., 1952) and dinitrophenol. 5,6-Dimethylbenzimidazole is a part of the vitamin  $B_{12}$  molecule and is related structurally to part of the riboflavin molecule. It has been found to possess inhibitory properties for the vitamin  $B_{12}$ -requiring organisms *Lactobacillus lactis* Dörner, *Lactobacillus leichmannii*, and *Euglena gracilis* (Hendlin et al., 1951).

Benzimidazole itself has been found to be a purine (Woolley, 1944) and nucleic acid (Klotz et al., 1948) antagonist, active in tissue cultures as a growth inhibitor of vaccinia (Thompson, 1947), psittacosis (Morgan, 1952) and poliomyelitis viruses (Brown, 1952). Recently Brown, et al. (1953) reported that benzimidazole prolonged the incubation period of infection and reduced mortality in experimental poliomyelitis in mice.

TABLE I.—EFFECT OF 2,5-DIMETHYLBENZIMIDAZOLE AND RELATED COMPOUNDS ON INCORPORATION OF  $N^{15}$  FROM  $N^{15}$ -GLYCINE INTO HEME BY ERYTHROCYTES OF CHICKEN BLOOD DURING *in vitro* INCUBATION

Experiment	$N^{15}$ concentration in hemin *		Supplement †
	Control	Test	
	atom per cent excess		
1	.076	.066	5mg 2,5-dimethylbenzimidazole
2	.066	.028	10mg 2,5-dimethylbenzimidazole
3	.060	.035	10mg 2,5-dimethylbenzimidazole
		.036	10mg 2,5-dimethylbenzimidazole + 15μg vit. $B_{12}$
4	.066	.041	10mg 2,5-dimethylbenzimidazole
5	.071	.009	15mg 2,5-dimethylbenzimidazole
		.009	15mg 2,5-dimethylbenzimidazole + 100μg vit. $B_{12}$
6	.073	.017	15mg 2,5-dimethylbenzimidazole
		.017	15mg 2,5-dimethylbenzimidazole + 25mg folic acid

Experiment	N <sup>15</sup> concentration in hemin *		Supplement †
	Control	Test	
	atom per cent excess		
7	.066	.003	20mg 2,5-dimethylbenzimidazole
		.042	20mg adenine
8	.066	.004	20mg 2,5-dimethylbenzimidazole
		.045	20mg benzimidazole
9	.071	.062	15mg benzimidazole
10	.072	.060	15mg 2-methylbenzimidazole
11	.081	.066	15mg 2-methylbenzimidazole
		.080	15mg orotic acid
12	.075	.062	15mg 2-methylbenzimidazole
		.061	15mg benzimidazole
13	.074	.035	15mg 5-methylbenzimidazole
		.037	15mg 5-methylbenzimidazole
14	.080	.029	15mg 5,6-dimethylbenzimidazole ‡
		.032	15mg 2,5-dimethylbenzimidazole
15	.082	.018	15mg 5,6-dimethylbenzimidazole ‡
		.066	15mg benzimidazole
16	.063	.012	15mg 2,5-dimethylbenzimidazole
		.003	20mg 5,6-dimethylbenzimidazole
17	.071	.006	20mg 5,6-dimethylbenzimidazole
18	.066	.054	5mg 2,5-dimethylbenzimidazole
		.022	5mg 2-ethyl-5-methylbenzimidazole
19	.080	.034	10mg 2,5-dimethylbenzimidazole
		.003	10mg 2-ethyl-5-methylbenzimidazole
20	.081	.008	20mg 2,5-dimethylbenzimidazole
		.051	3mg 2-ethyl-5-methylbenzimidazole
21	.078	.046	2mg 2-ethyl-5-methylbenzimidazole
		.042	20mg benzimidazole

\* Hemin isolated from chicken blood has slightly increased N<sup>15</sup> concentration over tank nitrogen similar to that of hemin from normal dog and human blood (Abbott et al., 1953). Values on the order of .002 to .006 atom per cent excess thus indicate complete inhibition of N<sup>15</sup> incorporation into heme.

† Benzimidazole, 2-methylbenzimidazole, 2,5-dimethylbenzimidazole and 2-ethyl-5-methylbenzimidazole were prepared by refluxing the appropriate diamine and acid according to the general procedure of Wagner and Millett (1944). The compounds were recrystallized several times, and melting points and nitrogen analyses were checked before use. 5-Methylbenzimidazole was recrystallized several times from the Eastman Kodak Company product. We are indebted to Dr. Karl Folkers of Merck and Co. for supplying 2,5-dimethylbenzimidazole for the initial experiments and for all of the 5,6-dimethylbenzimidazole used. Folic acid was kindly supplied by Lederle Laboratories through the courtesy of Dr. B. L. Hutchings. Other supplements were commercial products.

‡ As the formic acid salt (24 per cent formic acid).

The possibility that 2,5-dimethylbenzimidazole, 5,6-dimethylbenzimidazole and 2-ethyl-5-methylbenzimidazole might be acting as purine or nucleic acid antagonists in hemoglobin synthesis is particularly attractive. If this mechanism were involved, these substituted benzimidazoles might prove to be much more potent nucleic acid antagonists or antiviral agents than benzimidazole itself.

The important work of Tamm, Folkers, Shunk, Heyl, and Horsfall (1953) on the inhibition of influenza virus multiplication by alkyl derivatives of benzimidazole has been described recently by Horsfall in The Harvey Lectures (1954). Not only has 2,5-dimethylbenzimidazole been found to be a more potent agent than benzimidazole in inhibiting multiplication of influenza A or B virus, but the inhibitory activities of the methyl-substituted benzimidazoles for *in vitro* heme synthesis are precisely in the same relative order as was found for virus multiplication inhibition, i.e., 2-methylbenzimidazole was about the same as benzimidazole, and the 5-methyl derivative was intermediate between the 2-methyl and the 2,5-dimethylbenzimidazole. 5,6-Dimethylbenzimidazole also inhibited virus multiplication at lower concentrations than benzimidazole. 2-Ethyl-5-methylbenzimidazole was one of the most potent of all. It was considered to be approximately 7 times more effective than 2,5-dimethylbenzimidazole and 19 times more so than benzimidazole (Tamm et al., 1953).

The striking coincidence of the relative inhibitory activities of these alkyl-substituted benzimidazoles for two widely different systems, *in vitro* hemoglobin synthesis by avian erythrocytes and virus duplication, indicates to us that some very fundamental mechanism underlying both processes is involved. This might be the result of selective inhibition of a basic step in the mechanisms whereby nucleic acid (or nucleoprotein) plays some very important role in biosynthesis. It is of interest to note that the 5 (or 6) position of benzimidazole is analogous to the 2 position of the purines. Recent discovery of 2-methyladenine (Dion et al., 1954, and Brown et al., 1954) and 2-methylhypoxanthine (Brown et al., 1954) in biological material brings attention for the first time to the existence of analogous methyl-substituted purines in nature.

#### ACKNOWLEDGMENT

We are very much indebted to Dr. William T. Ham and the Biophysics Department for use of the mass spectrometer and to Mr. Hyman Rosen for preparation of the  $N^{15}$ -glycine used.

#### SUMMARY

2,5-Dimethylbenzimidazole, 5,6-dimethylbenzimidazole and 2-ethyl-5-methylbenzimidazole prevent incorporation of  $N^{15}$  from  $N^{15}$ -glycine into heme by chicken erythrocytes during *in vitro* incubation. Benzimidazole and 2-methylbenzimidazole had slight, but not comparable, inhibitory action. 5-Methylbenzimidazole had an inhibitory effect intermediate between that of benzimidazole and 2,5-dimethylbenzimidazole. 2-Ethyl-5-methylbenzimidazole was the most potent of all.



The striking coincidence of the relative inhibitory activities of the substituted benzimidazoles for two widely different systems, *in vitro* hemoglobin synthesis by avian erythrocytes and virus duplication, indicates to us that some very fundamental mechanism underlying both processes is involved. This might be the result of selective inhibition of a basic step in biosynthetic mechanisms in which nucleic acid (or nucleoprotein) plays some very important role.

## REFERENCES

- ABBOTT, L. D., JR. AND M. DODSON. 1952. Experiments on the *in vitro* Synthesis of Hemoglobin by Erythrocytes. *Va. Journ. Sci.*, 3: 346.
- ABBOTT, L. D., JR., M. J. DODSON, AND R. H. POWELL. 1953. Natural Abundance of N<sup>15</sup> in Hemin and Plasma Protein from Normal Blood. *Proc. Soc. Exp. Biol. and Med.*, 84: 402-404.
- BROWN, F. B. AND E. LESTER SMITH. 1954. New Purines in B<sub>12</sub> Vitamins. *Biochem. J.*, 50: xxxiv-xxxv.
- BROWN, G. C. 1952. The Influence of Chemicals on the Propagation of Poliomyelitis Virus in Tissue Culture. *J. Immunol.*, 69: 441-450.
- BROWN, G. C., D. C. CRAIG, AND A. KANDEL. 1953. Effect of Benzimidazole on Experimental Poliomyelitis in Mice and Monkeys. *Proc. Soc. Exp. Biol. and Med.*, 83: 408-411.
- DION, H. W., D. G. CALKINS, AND J. J. PFIFFNER. 1954. 2-Methyladenine, an Hydrolysis Product of Pseudovitamin B<sub>12d</sub>. *J. Am. Chem. Soc.*, 76: 948-949.
- EMERSON, G., N. G. BRINK, F. W. HOLLY, F. KONIUSZY, D. HEYL, AND K. FOLKERS. 1950. Vitamin B<sub>12</sub>. VIII. Vitamin B<sub>12</sub>-like Activity of 5,6-dimethylbenzimidazole and Tests on Related Compounds. *J. Am. Chem. Soc.*, 72: 3084-3085.
- FISCHER, H. 1941. Hemin. *Org. Syntheses*, 21: 53-55.
- HENDLIN, D. AND M. H. SOARS. 1951. The Effect of 5,6-dimethylbenzimidazole and Related Compounds on the Growth of *Lactobacillus lactics* Dorner. *J. Bact.*, 62: 633-647.
- HORSFALL, F. L., JR. 1954. Experiments on Chemical Alteration of Virus Infections. *The Harvey Lectures*, 48: 35-67.
- KLOTZ, I. M. AND M. MELLODY. 1948. The Reversal of Benzimidazole Inhibition of Growth by Nucleic Acid. *J. Bact.*, 56: 253-255.
- MORGAN, H. R. 1952. Factors Related to the Growth of Psittacosis Virus (Strain 6BC) II. Purines, Pyrimidines, and Other Components Related to Nucleic Acid. *J. Exp. Med.*, 95: 277-283.
- SCHOENHEIMER, R. AND S. RATNER. 1939. Studies in Protein Metabolism. III. Synthesis of Amino Acids Containing Isotopic Nitrogen. *J. Biol. Chem.*, 127: 301-313.
- SHEMIN, D., I. M. LONDON, AND D. RITTENBERG. 1948. The *in vitro* Synthesis of Heme from Glycine by the Nucleated Red Blood Cell. *J. Biol. Chem.*, 173: 799-800.

- , 1950. The Synthesis of of Protoporphyrin *in vitro* by Red Blood Cells of the Duck. *J. Biol. Chem.*, 183: 757-765.
- SHEMIN, D. AND D. RITTENBERG. 1946. The Biological Utilization of Glycine for the Synthesis of the Protoporphyrin of Hemoglobin. *J. Biol. Chem.*, 166: 621-625.
- TAMM, I., K. FOLKERS, C. H. SHUNK, D. HEYL, AND F. L. HORSFALL, JR. 1953. Inhibition of Influenza Virus Multiplication by Alkyl Derivatives of Benzimidazole. III. Relationship between Inhibitory Activity and Chemical Structure. *J. Exp. Med.*, 98: 245-259.
- THOMPSON, R. L. 1947. The Effect of Metabolites, Metabolite Antagonists and Enzyme-inhibition on the Growth of the Vaccinia Virus in Maitland Type of Tissue Cultures. *J. Immunol.*, 55: 345-352.
- WAGNER, E. C. AND W. H. MILLETT. 1944. Benzimidazole. *Org. Syntheses* Coll., Vol. 2: 65-66.
- WOOLLEY, D. W. 1944. Some Biological Effects Produced by Benzimidazole and Their Reversal by Purines. *J. Biol. Chem.*, 152: 225-232.

## The Eggs of the Slimy Salamander in Isle of Wight County, Virginia.

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Reported here is a description of a group of eggs of the slimy salamander, *Plethodon glutinosus glutinosus* (Green), found on May 30, 1953, in the Carrsville area of Isle of Wight County. The literature contains only three descriptions of the nest of this subspecies. In 1929 Noble and Marshall reported on two nests found in Arkansas caves, and in 1940 Fowler described a nest found in a rotting stump in West Virginia. The Carrsville nest consisted of seven adherent eggs found in a depression in a damp pile of paper cement bags. The shifting of the bags during the collecting operation made it impossible to determine whether or not a female had been guarding the eggs immediately prior to their exposure. Five salamanders were also collected from the bag heap, and all were *P. g. glutinosus*. Four of the salamanders were adults, and one was a juvenile. Three of the adults were females, and two of these had fully gravid ovaries but no large ova in their oviducts (evidence that they had not been depositing eggs recently). The remaining adult female had "spent" ovaries, containing no large ova. This female was probably the source of the egg group.

The eggs were arranged in a compact cluster, and were loosely connected by the adherence of their outer envelopes. Their general proportions and the character of their envelopes approximated closely those of the diagrammatic *Plethodon glutinosus* egg illustrated in Bishop's report (1941). They did not bear any resemblance to the diagrammatic *Plethodon cinereus* egg in the same report, the only other salamander egg that in any probability might have been found in the same habitat. The eggs did not closely approximate those described by Noble and Marshall (loc. cit.) in that they did not appear to have been contained in a "common envelope". The vitelline membrane was closely adherent over a faintly yellowish deutoplasmic mass. A diffuse light pigmentation of melanophores darkened the animal pole. The envelopes surrounding the vitelline membrane were thin, and could not be distinctly separated in binocular microscopic examination due to a cloudiness resulting from inadequate preservation. The eggs were in the early gastrula stage at the time of collection, and were preserved in the field shortly after their discovery.

The probable relationship of an adult female specimen to the eggs was suggested by the presence of adequate space beside the eggs for an attending adult. It is well known that adult *Plethodon cinereus* remain

\* Paper received July 1, 1954.



near egg groups, and it is likely that this behavior is also characteristic of *glutinosus*. It was not possible to determine whether or not the eggs were suspended from the top of the crevice prior to their being exposed in collecting. It is of interest to note that one of the egg masses reported by Noble and Marshall was suspended in a crevice, and the other was found lying on the bottom of a similar niche. This is more likely the result of poor adherence of their eggs than of variable behavior of the females during egg deposition.

The Carrsville eggs were smaller than those described by Noble and Marshall (loc. cit.) who report "an average egg" measures 5.5 mm. in diameter, inner envelope 6 mm., outer envelope 6.5 mm., and the "common envelope or outer sphere" (Piersol, 1915) is variable in thickness, bringing the total diameter of the egg and capsules to about 7.5 mm. An average egg in the Carrsville group had a yolk mass of 3.5 to 4.0 mm. diameter, and the maximum diameter including the envelopes ranged from 5.0 to 5.5 mm. The difference between the dimensions of these two series of eggs may reflect a zoogeographic factor, but it is not possible to ascribe much importance to this possibility in light of the paucity of data. Other factors affecting total egg dimensions include the amount of water absorption which has taken place prior to preservation, the amount of shrinkage after preservation, and variations in the dimensions of eggs produced by different specimens of the same species. There has never been any report on the range in dimensions of *Plethodon* eggs at the time of deposition.

The two gravid females in the habitat of the egg group had full ova complements. The larger specimen (snout-vent length: 62.5 mm.) had 19 large ova; the smaller (snout-vent length: 61.5 mm.) had 16. The snout-vent length of the female with "spent" ovaries was 56.8 mm.

Noble and Marshall (loc. cit.) found eggs in "cleavage stages" on August 17, 1928, in Sheridan Cave, Mountain Home, Arkansas. Fowler (1940) found eggs on June 3, 1938, in a wooded valley near Ice Mountain, Hampshire County, West Virginia. Pope and Pope (1949) report that the height of the breeding season in the vicinity of Mountain Lake, Giles County, Virginia is between July 27 and August 9. The authors believe that the finding of an egg group in late May in Tidewater Virginia is not incompatible with these data, and it is not strong evidence for an extended breeding season. Although Bishop (1941, 1943) believes that *Plethodon glutinosus* eggs are deposited in New York before May, or possibly during that month, his conclusion is based upon circumstantial evidence. No direct proof has been obtained that this species breeds that early in a northern state, and "it scarcely seems possible that this species would breed at one season in the lowlands of central and southern New York and at another in the high mountains of Virginia; in fact, one would expect coincidence of breeding seasons in these two areas" (Pope and Pope, loc. cit.). It would certainly be unusual if the breeding season in central New York approximated, or preceded that in the lowlands of the eastern Virginia coastal plain.

Noble and Marshall (loc. cit.) concluded on the basis of their two nests that in regions where no caves occur "the adults penetrate into the ground for some depth to deposit their eggs, and the young, in seeking the outer world, follow crevices such as those formed by ground-waters and make their exit (from their subterranean nursery) — near springs." This is possible but not supported by proof. Nests found by Fowler (loc. cit.) and the authors support the view that eggs are deposited in various secluded spots in the usual habitat of the species. All of the nesting sites described are characteristically troglodytic, whether the "cave" is a crevice in a true cave, a dark hollow in a rotting stump, or an artificial cavity in a pile of soggy cement bags.

The number of eggs in the Carrsville series is small. Pope and Pope (loc. cit.) found the mean for large ova in gravid females to be 23.4, and the range, 17 to 33. They report, "since a few large eggs are found in the spent females it is not surprising that the dissected females held more eggs than the nests. Even if all the large eggs were laid there would probably be some post-laying loss." It is not possible to determine whether the seven eggs near Carrsville comprised a full complement of one female, but the only female found in the habitat who had been depositing eggs recently had no large ova retained in her ovaries or oviducts.

#### LITERATURE CITED

- BISHOP, S. C. 1941. The Salamanders of New York. *N. Y. State Mus. Bull.*, (324): 1-365.
- BISHOP, S. C. 1943. The Handbook of Salamanders. *Comstock Publ. Co.*, Ithaca, N. Y., pp. 1-555.
- FOWLER, J. A. 1940. A Note on the Eggs of *Plethodon glutinosus*. *Copeia*, (2): 133.
- NOBLE, G. K. AND B. C. MARSHALL. 1929. The Breeding Habits of Two Salamanders. *Amer. Mus. Nat. Hist., Novitates*, (347): 1-12.
- PIERSOL, W. H. 1915. The Egg-laying Habits of *Plethodon cinereus*. *Trans. Can. Inst.*, 10: 121-26.
- POPE, C. H. AND S. H. POPE. 1949. Notes on Growth and Reproduction of the Slimy Salamander *Plethodon glutinosus*. *Chic. Nat. Hist. Mus., Fieldiana*, 31(29): 251-61.

## A Simplified Method For The Determination of Azo Dyes in Tissues, Urine and Feces <sup>1</sup>

J. D. SPAIN <sup>2</sup> AND C. C. CLAYTON

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The final criterion for carcinogenicity of azo dyes as related to chemical structure (Miller and Miller, 1948) or dietary variation (Griffin and Baumann, 1948; Kensler, 1947-48; Miller, 1947-48) is the tumor incidence. Some indication, however, of the effect of these variables may be ascertained in a shorter time by the degree of cirrhosis (Miller and Miller, 1948), liver riboflavin concentration (Griffin and Baumann, 1948; Miller, Miller, Kline, and Rusch, 1948) and/or liver protein-bound azo dyes (Miller and Miller, 1947; Miller, Miller, Sapp and Weber, 1949). The method of Miller and Miller (1947) for the determination of the protein-bound dyes involves a number of time-consuming procedures which limit its usefulness when large numbers of analyses are involved. Therefore a method was developed for the determination of total azo dyes in tissues which required a minimum of time and equipment.

### REAGENTS

95 per cent ethanol

11 N KOH (Approx.) Equal weights of 85 per cent U.S.P. KOH and of water

Concentrated hydrochloric acid, C.P.

Acid-alcohol solution: 16 gm. KCl, 50 ml. of 95 per cent ethanol, 100 ml. of concentrated HCl, made up to 500 ml. with water. This 2.4 N HCl solution approximates that obtained by the acidification and dilution of the KOH digest (see below) and is useful in dilutions of the azo dyes for reading in the colorimeter.

Stannous chloride-acid solution: 60 gm. of stannous chloride dissolved and made up to 100 ml. with concentrated HCl.

### PROCEDURE

Rats which had been fed 3'-methyl-4-dimethylaminoazobenzene (3'me-DAB) were sacrificed by decapitation and the livers removed and weighed. Three gm. samples were removed from the left lateral and median lobes, homogenized with an all-glass tissue grinder, and made to 25 ml. with distilled water. Samples of 5 ml. of the homogenate were placed

<sup>1</sup> From a portion of a thesis submitted in partial fulfillment of the requirements for the degree of Master of Science by J. D. Spain, and presented in part at the Annual Meeting of the Virginia Academy of Science, Charlottesville, May, 1954. Supported in part by a grant-in-aid from the American Cancer Society upon recommendation of the Committee on Growth of the National Research Council and by research grant C-1541 of the National Cancer Institute of the National Institutes of Health, Public Health Service.

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\* Paper received September 29, 1954.



in 50 ml. Erlenmeyer flasks with 7 ml. of 95 per cent ethanol and 2 ml. of 11 N KOH. The contents were mixed, and then refluxed for 20 hours at 80° C. (ether extraction-type hotplate) using cold-finger condensers. This method of liberating the dye was similar to that of Miller and Miller (1947) and found by them and from our studies to be the most satisfactory.

The slightly cloudy, yellow digests were then cooled below 15° C. individually in an ice bath and acidified to the pink azo dye color with additions of concentrated HCl dropwise with continued cooling and swirling. The slightly acid solution was washed into a 50 ml. graduated cylinder and diluted to 40 ml. with distilled water. Ten ml. of concentrated HCl were added and the contents mixed by inversion. The cylinder of acidified digest was allowed to stand for about 10 minutes in an ice-water bath and then filtered through rapid paper (Munktell's No. 3). The fatty acids and other acid-insoluble materials were removed leaving a clear, non-turbid filtrate.

The concentration of dye in the filtrate was determined with the Evelyn colorimeter using a 515 filter, the galvanometer being set at 100 with the acid-alcohol solution. Each sample served as its own blank by being re-read following reduction of the azo dyes by the addition of one drop of stannous chloride solution to 20 ml. of the filtrate. The optical density of the azo dyes was found by subtracting the optical density of the blank (L values with the Evelyn colorimeter) from the optical density of the original filtrate. If this value were multiplied by  $10^4$ , we obtained an arbitrary number representing the units of azo dye in the sample diluted as outlined. One microgram of 3'-me-DAB was equivalent to 50 units. The azo dye color in the acid filtrate solution used for colorimetric reading was stable at room temperature for over 24 hours. This procedure is a measure of the total azo dye in the liver.

Animals which did not receive the dye had a very slight amount of material in the acidified liver digest which lost color with the stannous chloride treatment. This we have called the "false dye" reading and amounted to only about 30 units in the aliquot of liver used. It was quite constant under the conditions employed and could be disregarded for most comparative studies. (Values reported were corrected for the false dye.) The apparent amount of false dye from the control animals was influenced by the normality of the acid solution used in the colorimetric measurements, becoming more intense as the solution became more acidic. At a normality of HCl between 2 and 3 the false dye correction was minimized and slight changes in normality had little effect.

The method was compared with that for bound dye of Miller and Miller (1947) which involves trichloroacetic acid (TCA) precipitation, alcohol extraction and KOH alcohol digestion of the protein, followed by ether extraction and colorimetric determination in acid after removal of the ether. The effect on the dye content of trichloroacetic acid and alcohol extraction of the protein was also determined using the simpler procedure described. Aliquots from a pooled homogenate from the livers

of two rats fed 3'-me-DAB for five weeks were **used in these studies** and results calculated to units of dye per gram of **fresh weight** of liver (Figure 1.).

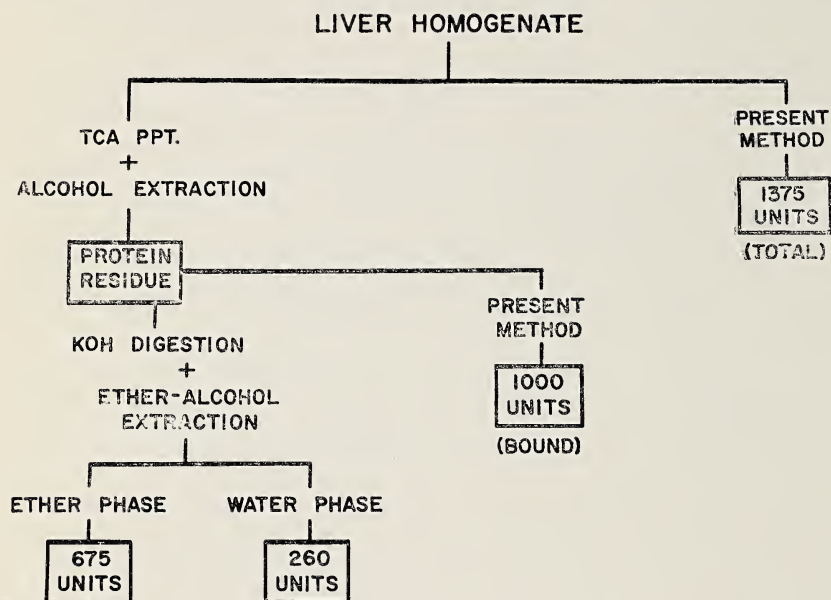


FIGURE 1.—Azo dye found in livers of rats fed 3'-methyl-4-dimethyl-aminoazobenzene for five weeks as measured by **different procedures**. (Units per gm. fresh weight).

When a sample of trichloroacetic acid (TCA) **precipitated**, alcohol washed protein (prepared according to Miller and Miller, 1947) was analysed by our procedure (5 ml. of water added to protein in digestion) it was found to contain 1000 units of the 1375 units of dye per gram originally present in the fresh homogenate. (Figure 1.). Approximately 25 per cent of the dye was extracted by alcohol and may be considered unbound or loosely bound.

Two ether extractions of the digest by the method of Miller and Miller (1947) did not remove all the dye from the alkaline solution, for when the aqueous residue was acidified and the color in **this portion** determined before and after reduction by stannous chloride it was found to contain 260 units. This amount plus the amount in the ether fractions accounted for 935 units which is comparable to the 1000 units found by the simpler procedure on the precipitated-alcohol extracted protein.

Modifications of the above procedure were found to work equally well with other tissues, urine, and feces. Urine and feces were collected in metabolism cages from rats which had been fed the dyes previously for

four weeks. The collection period was eight hours during which time the animals were given water but no food. This resulted in a collection that was not contaminated by diet. A measured amount of alcohol was added to the urine-collecting containers as a preservative. The urine was acidified to approximately 2.4 N with HCl, filtered, and diluted with the acid-alcohol solution for the colorimetric readings. Feces were macerated, allowed to stand for 20 hours in the acid-alcohol solution, then filtered, diluted, and the azo dye concentration determined.

### ANIMAL EXPERIMENTS

Animals fed the dye, 3'-me-DAB, were killed at weekly intervals and the total liver azo dye determined. The amount of dye per gram of liver increased rapidly for the first three weeks to a level of 1800 units, after which there was a gradual, progressive decrease to the sixth week (when the experiment was terminated) when 1400 units of dye per gram of liver were found. This change in total liver azo dye concentration with time was similar to that found by Miller, Miller, Sapp, and Weber (1949) for their protein-bound dye. Routine determinations of rat livers in duplicate for azo dye resulted in a deviation from the mean of less than two per cent.

Less total azo dye was found in the liver after five weeks of dye feeding when the diet contained 5  $\mu$ gm. of riboflavin per kilogram of diet than when it contained 1  $\mu$ gm. of the vitamin. This is in line with the results of Miller and Miller (1947).

Azo dyes were also found in the urine and feces when 3'-me-DAB was fed. The amount in the urine varied between 1000 and 5000 units per rat per day while the feces were found to contain between 5000 and 10,000 units per day, based on an eight hour collection. The daily ingestion of the dye by the animals was approximately 320,000 units (10 gm. of 0.064 per cent 3'-me-DAB). Very little dye could be detected in the spleen or kidneys.

The method worked equally well for the determination of liver dye after feeding the less active carcinogen, 4-dimethylaminoazobenzene, although the amount per gram of liver was less. (cf. Miller, Miller, Sapp, and Weber 1949). No dye could be detected in the urine when this dye was fed.

### DISCUSSION

With a simple rapid method for the determination of liver azo dye, it may be possible to ascertain more readily factors that affect the level of these compounds in the liver and the significance of these liver dyes and azo dye hepato-carcinogenesis. Present studies indicate the same trend in liver total azo dyes with respect to time and dietary variation as was found previously with protein-bound liver dyes. Should further investigation show that the bound liver dye is of more value than the total, a procedure of trichloroacetic acid (TCA) precipitation and alcohol extraction with the method as outlined would eliminate the processes of



drying, extraction, and solvent evaporation employed by Miller and Miller (1947). Such a procedure would give the total protein bound azo dye, whereas the use of organic solvent extraction removes and measures a portion of the dye.

Miller, Kline, Rusch, and Baumann (1944) and Spain (1953) have shown that various azo dyes have different distribution coefficients between chloroform and aqueous phases. From such distribution studies, Spain (1953) has evidence that the dyes present in the urine of rats fed 3'me-DAB are not the compound fed but are quite like those metabolites found in the livers of rats fed this compound. Furthermore, these solvent distribution studies and preliminary experiments with paper and column chromatography (unpublished) indicated that there were a number of dyes present in the liver and urine. Should such be the case, it may be that total or protein-bound dyes are not the main factors to be evaluated, but rather one or more definite dye metabolites and its, or their, influence on the carcinogenic process.

### SUMMARY

A simple rapid method is described for the determination of total azo dye in tissues by alkaline digestion, acidification and filtration, and determination of color before and after reduction with stannous chloride. The method is compared with more time consuming methods now available. The method was also used for the determination of azo dyes in urine and feces.

### REFERENCES

- GRIFFIN, A. C. AND C. A. BAUMANN. 1948. Hepatic Riboflavin and Tumor Formation in Rats Fed Azo Dyes in Various Diets. *Cancer Research*, 8: 279-284.
- KENSLER, C. J. 1947-48. Effect of Diet on the Production of Liver Tumors in the Rat by N,N-Dimethyl-p-aminoazobenzene. *Ann. N. Y. Acad. Sci.*, 49: 29-40.
- MILLER, E. C. AND J. A. MILLER. 1947. The Presence and Significance of Bound Aminoazo Dyes in the Livers of Rats Fed p-Dimethylaminoazobenzene. *Cancer Research*, 7: 468-480.
- MILLER E. C., J. A. MILLER, B. E. KLINE, AND H. P. RUSCH. 1948. Correlation of the Level of Hepatic Riboflavin with the Appearance of Liver Tumors in Rats Fed Aminoazo Dyes. *J. Exper. Med.*, 88: 89-98.
- MILLER, E. C., J. A. MILLER, R. W. SAPP, AND G. W. WEBER. 1949. Studies on the Protein-bound Aminoazo Dyes formed *in vivo* from 4-Dimethylaminoazobenzene and its C-Monomethyl Derivatives. *Cancer Research*, 9: 336-343.

- MILLER, J. A. 1947-48. Studies on the Mechanism of the Effects of Fat and Other Dietary Factors on Carcinogenesis by the Azo Dyes. *Ann. N. Y. Acad. Sci.*, 49: 19-28.
- MILLER, J. A., B. E. KLINE, H. P. RUSCH, AND C. A. BAUMANN. 1944. The Carcinogenicity of p-Dimethylaminoazobenzene in Diets Containing Hydrogenated Coconut Oil. *Cancer Research*, 4: 153-158.
- MILLER, J. A. AND E. C. MILLER. 1948. The Carcinogenicity of Certain Derivatives of p-Dimethylaminoazobenzene in the Rat. *J. Exper. Med.*, 87: 139-156.
- SPAIN, J. D. 1953. The Reticulo-Endothelial System in Azo Dye Carcinogenesis. *Thesis* Medical College of Virginia, Richmond, Va.

# The Stereographic Projection of the Crystallographic Angles of *Beta-tin* \* †

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The determination of the orientation of metallic single crystals by X-ray back reflection analysis is a well-established technique. In order to carry out this technique it is necessary to know the angles between the important crystallographic planes. Such angles have been tabulated by Bozorth (1925) for the cubic metals and by Salkovitz (1951) for the hexagonal metals, magnesium, zinc, and cadmium. A table of the crystallographic angles of *beta-tin* has been published by Nicholas (1951) but the number of angles tabulated is generally insufficient to determine the orientation from the Laue back reflection photograph. Only 67 angles were given by Nicholas for planes making angles less than 60° with one another. A 60° angle is the maximum angle which can be determined from conventional back reflection X-ray photographs.

Using the equation for tetragonal metals,

$$\cos \phi = \frac{\frac{h_1 h_2}{a^2} + \frac{k_1 k_2}{a^2} + \frac{l_1 l_2}{c^2}}{\sqrt{\left(\frac{h_1^2}{a^2} + \frac{k_1^2}{a^2} + \frac{l_1^2}{c^2}\right) \left(\frac{h_2^2}{a^2} + \frac{k_2^2}{a^2} + \frac{l_2^2}{c^2}\right)}},$$

where  $\phi$  is the angle between the planes ( $h_1 k_1 l_1$ ) and ( $h_2 k_2 l_2$ ), and  $a$  and  $c$  are the lengths of the  $a$  and  $c$  axes, 310 angles were calculated between planes making angles less than 60° with one another. Values of  $a = 5.831$  and  $c = 3.182$  were taken from the work of Swanson and Tatge (1953). From the calculated angles the stereographic projection shown in Figure 1 was constructed. For most purposes angles can be taken from the stereographic projection with sufficient accuracy for orientation determination. It is useful, however, to have the angles in tabular form when in the process of identifying the Laue spots. Since these angles would consume too much space in the *Journal*, copies will be supplied to interested readers on request by the author, 326 N. Boulevard, Richmond 20.

\* These results were obtained during the course of a study sponsored by the American Can Company.

† *Beta-tin*, or white tin, is a member of space group  $D_{4h}^{16}$  (I4/amd), a body-centered lattice with 2 atoms in the unit cell. It transforms to the low-temperature *alpha* form, or gray tin, at approximately 13° C.

\*\* Paper received February 1, 1955.





## A Note on Spore Germination in *Psilotum nudum*

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An unsuccessful attempt was made to germinate spores of *Psilotum nudum* (L.) Beauv. using the method described by Darnell-Smith (1918)<sup>1</sup>, i.e., placing them between thin slabs of limestone in a fine layer of soil. Success was obtained, however, by mixing spores with Minnesota black soil and coarse sand, placing the mixture in an 8-inch clay pot, and planting a specimen of *Aspedistra* in the mixture. This was a duplication of the conditions under which mature gametophytes had been found growing. Periodically a soil sample was removed and examined for germinating spores.

The first indication of germination is the opening of the spore wall along the longitudinal slit, followed by the bulging of the spore contents out of the wall. This is followed by the first cell division which cuts off a relatively small cell at the apex of the bulge by an oblique wall. According to Darnell-Smith (1918), the first division occurs from 3 to 5 months after the spores are placed in an environment suitable for germination. Although spores were recovered at frequent intervals during the present study, the culture was 15 months old at the time of the first recovery of germinating spores. After the 15 month period, approximately 60 per cent of all the spores recovered were still alive, and of these approximately 50 per cent showed signs of germination. Of those that showed signs of germination, approximately 50 per cent were still in the one-celled stage and the remainder in the two-celled stage.

The subsequent stages, as described by Darnell-Smith, are characterized by cell divisions resulting in a tear-drop-shaped object very similar in appearance to a young plant of gemma-origin. Only one such plant was recovered during the present study, and this was 26 months after the spores were sown. Its total length was 0.5 mm., and it was easily distinguished from a plant of gemma-origin by the absence of a gemma or gemma scar. The spore wall was not attached.

<sup>1</sup> Darnell-Smith, G. P. 1918. The gametophyte of *Psilotum*. Trans. Roy. Soc. Edin., 52: 79-91.

\* Paper received January 25, 1955.

## News and Notes

### MINUTES OF THE COUNCIL MEETING, OCTOBER 31, 1954

The meeting of the Council of the Virginia Academy of Science was held at 2:00 P.M. in Mallory Hall, The Virginia Military Institute, Lexington, Virginia. Present were Lloyd C. Bird, Byron Cooper, President-elect Walter S. Flory, Jr., Allan T. Gwathmey, William M. Hinton, Horton H. Hobbs, Jr., Boyd Harshbarger, Edward S. Harlow, Sidney S. Negus, Paul M. Patterson, Foley F. Smith, and Stanley B. Williams. Also present, by invitation, were Emmert Ikenberry and A. M. Showalter, of Madison College, Harrisonburg; and Mrs. Thelma C. Heatwole, Chairman of the Junior Academy of Science Committee. President Irving G. Foster presided.

Minutes of the last Council meeting at the Annual May meeting were read and approved. Sidney Negus read the resumé of the life and career of Dr. E. C. L. Miller, late Secretary-Emeritus of the Academy, and then the resolutions adopted by the Council. On proper motion it was moved, seconded, and passed that this resumé and resolutions be made a permanent part of the minutes and archives of the Academy. The resolutions follow as part of these minutes, and were published separately in the January issue of the Virginia Journal of Science, Volume 6, New Series, No. 1, page 1.

The resolutions concerning the death of Justus Henry Cline prepared by Marcellus S. Stow, were also read, and it was moved, seconded, and passed that these resolutions be incorporated in the minutes of the Council, and that a copy be sent to Mrs. Cline. These resolutions (*loc. cit.*, p. 56) were accepted by a rising vote of the members of the Council present.

Professors Showalter and Ikenberry were present to discuss the arrangements for the annual meeting of the Academy at Madison College, Harrisonburg, May 12-14.

The guest speaker for the May meeting was among the items discussed, and it was suggested that for this meeting we invite as speaker a distinguished meteorologist, instead of a physicist, and that the selection of the speaker be left in the hands of the President. It was suggested that Professors Ikenberry and Showalter also make arrangements to meet with Fred Young, Chairman of the Local Committee on Arrangements at the last annual meeting at the University of Virginia.

Future meeting places of the Academy were discussed, and an invitation to plan a joint meeting with the Tennessee Academy in Bristol was tabled at this time.

The Speakers' Bureau was next discussed, and it was decided to continue this Bureau for one more year for those who might wish to take advantage of the Bureau's facilities for furnishing authorities in scientific fields to speak before local groups.



Walter S. Flory next reported for the Committee to study the Virginia Science Talent Search. This rather full report was read to the Council, and the recommendations of this committee were approved and accepted.

Edward S. Harlow reported for the Long Range Planning Committee on Secondary Science Education. This meeting of the Committee was held in Richmond on October 2, 1954, and in addition to discussing the Science Education program, the Virginia Science Talent Search, the James River Basin Monograph, and the National Scientific Manpower problem were considered. This report was also approved and accepted. Copies of the report may be obtained from the Secretary, or from Mr. Edward S. Harlow, Chairman of the Committee.

It was moved, seconded and passed, that a committee be appointed to consider a request for funds to finance a study of State Science Search winners either from the National Science Foundation, or other such foundations.

It was suggested that a condensed version of the James River Basin be offered for sale at Jamestown Exposition, 1957. It was moved, seconded, and passed, that a Committee be appointed to confer with the Jamestown Exposition Commission, concerning any help that the Academy might offer in any capacity in which the facilities of the Academy might be used.

Boyd Harshbarger, Editor-in-Chief of the Journal, reported that a renewal of the printing contract, had been offered by Mr. Malcolm Donald Coe, Editor and Publisher of the Giles County Virginian, in Pearisburg. It was moved, seconded and passed that this bid be accepted for printing the Virginia Journal of Science for the next two years.

Dr. Harshbarger also suggested, and it was moved, seconded and passed, that Section 5, Paragraph 4, of the by-laws be changed to read: The staff shall be composed of: an Editor, an Associate Editor, and a Managing Editor instead of "an Editor-in-Chief, a Technical Editor, an Assistant Technical Editor—and the title Editor-in-Chief be changed to Editor wherever it might appear elsewhere in the by-laws and the other titles concerned above be changed respectively. Publications of this notice in the January issue of the Virginia Journal of Science will constitute official notice to the membership of the Academy; and this change will be voted on at the annual Academy Conference at Harrisonburg.

The Editorial Board of the Virginia Journal of Science was unanimously re-appointed and re-elected for another term, and received the official commendation of the Council for a job well done.

It was suggested that the committee on Place of Meeting for 1956 contact the Richmond Area University Center as a possible host to the Academy in planning a Richmond meeting in 1957.

The official thanks and appreciation were extended by the Council to Colonel and Mrs. I. G. Foster for their gracious hospitality to the Council, their wives, and guests at the very delightful buffet luncheon served at their home before the meeting.

There being no further business, the meeting adjourned at 4:15 P.M.

—FOLEY F. SMITH, *Secretary*

## SECTION NEWS

## AGRICULTURAL SCIENCE SECTION

Dr. W. K. Stone has been appointed to the newly created position of Professor of Dairy Husbandry in Dairy Manufacturing Research at Virginia Polytechnic Institute. Dr. Stone received his undergraduate degree and his M.S. degree at Utah Agricultural College and his Ph.D. degree at the University of Wisconsin. Prior to coming to Blacksburg he was employed by the Food and Can Institute, U. S. Army Corps, Chicago, Illinois.

Dr. V. L. Baldwin assumed his duties as Associate Professor of Dairy Husbandry and Associate Dairy Husbandman of the Virginia Agricultural Extension Service on February 15. He is a graduate of the University of Minnesota and received his B.S., M.S. and Ph.D. degrees from that institution. Prior to coming to Virginia Polytechnic Institute he was on the staff of the Dairy Department at the University of Minnesota.

The Farm and Home Development phase of the Agricultural Extension program is rapidly getting under way in Virginia. A training school for county Extension workers of 16 pilot counties, two others that may become such, and for specialists was held at Virginia Polytechnic Institute December 13-18. Training schools were also held in the five supervisory districts for white county workers in non-pilot counties. A training school for Negro workers was held at Petersburg February 28-March 2.

In the pilot counties, 19 additional workers have been employed to carry out the activity, with provision for a number of additional ones. The funds provided by the 83rd Congress were intended largely for use on the county level but did provide for some additional personnel on the State level to take care of critical needs. Work in the non-pilot counties will be conducted with only a few families by present county staff members.

This emphasis placed on Farm and Home Development is in recognition of a need to assist farm families to analyze their present economic status and to initiate plans for long range progress.

Mr. L. B. Wilkins has been appointed Associate Professor of Horticulture, effective March 1, 1955, to serve as Extension Vegetable Specialist at Virginia Polytechnic Institute. He will make his headquarters at Blacksburg and will coordinate the activities of the several specialists working in the field of vegetable production. Mr. Wilkins took his college training in Agricultural Economics at Virginia Polytechnic Institute, receiving his B.S. degree in 1933 and his M.S. degree in 1934. He has served as County Agent of Norfolk County for a number of years.

Mr. Edsel L. Phillips has been appointed Associate Professor of Horticulture at Virginia Polytechnic Institute effective March 15, 1955. He will be located at the Piedmont Research Laboratory at Charlottesville, Virginia. Mr. Phillips will serve half time as a Fruit Extension Specialist and give half time to research. He received his B.S. degree in Horticulture from the University of Idaho in 1950. He comes to Virginia after

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OVENS

PYREX GLASSWARE

SPECTROPHOTOMETERS

IRONWARE



having served for several years on the staff of the Mississippi Agricultural Experiment Station.

Mr. Jerry B. Hardigree has been appointed Instructor of Horticulture at Virginia Polytechnic Institute effective January 1, 1955. He will assist with the research work in fruit breeding. Mr. Hardigree received his B.S. degree in Horticulture from the University of Georgia.

Mr. James D. Ashley has been appointed Instructor of Horticulture at Virginia Polytechnic Institute effective March 1, 1955. He will be responsible for producing vegetable and floriculture crops at the greenhouses for use in research and teaching. Mr. Ashley received his B.S. degree in Horticulture at Virginia Polytechnic Institute in June, 1948.

Mr. Andrew J. Lambert has been appointed Associate Extension Agricultural Engineer at Virginia Polytechnic Institute. Mr. Lambert received his B.S. degree in Agricultural Engineering at this institution in 1950. He was formerly employed as Agricultural Engineer by the Appalachian Electric Power Company at Rocky Mount, Virginia.

Dr. Robert A. Barton, Veterinary Field Supervisor, Division of Animal Industry, Department of Agriculture of Virginia, resigned December 15, 1954, to accept a position in the Procurement Department of Kingan and Company at their Richmond Plant. Dr. Barton had nine years' experience as a practicing veterinarian before entering State service in 1950. He is a native of New York and a graduate of the University of Pennsylvania.

Dr. Bryan Baker, Jr. has been appointed Associate Professor of Animal Husbandry at Virginia Polytechnic Institute. His responsibilities will include three-fourths time teaching and a fourth time research. He replaces Robert A. Edgar, who resigned in November to accept a position at the Mississippi Station.

The Animal Husbandry Department of Virginia Polytechnic Institute presented four papers at the Southern Agricultural Workers' Meeting at Louisville, Kentucky: one paper by H. R. Thomas, C. C. Brooks and C. M. Kincaid entitled "BOF Tankage as a Source of Protein Supplement for Swine"; another one by K. C. Williamson, "Factors Influencing Prices Paid for Feeder Calves in Virginia Calf Sales"; and another, "Feeding of Peanut Hulls" by H. R. Thomas and C. M. Kincaid; the fourth paper by Dr. C. M. Kincaid on the "Relationship of Offal to the Weight and Age of Cattle."

The Association of Southern Agricultural Workers met at Louisville, Kentucky on February 7, 8, and 9. R. K. Stivers of Virginia Polytechnic Institute's Agronomy Department presented a paper before the Soils Division of the Agronomy Section. It was entitled "Relation of Subsoiling, Deep Lime and Deep Phosphate Application to the Yields of Corn, Peanuts and Alfalfa in Virginia" by R. K. Stivers, J. H. Lillard, G. D. Jones and A. H. Allison.

The American Society of Agronomy met in Saint Paul, Minnesota November 8-12, 1954. R. K. Stivers presented a paper entitled "The Correlation of Soil Tests with Crop Response in Virginia" by R. K. Stivers, C. I. Rich and R. E. Blaser, Virginia Polytechnic Institute.



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Dr. Walter S. Wilkinson has been appointed Associate Professor of Animal Husbandry and Associate in Biochemistry and Nutrition at Virginia Polytechnic Institute. Dr. Wilkinson secured his Ph.D. degree from the University of Wisconsin. He assumed his duties on January 15, 1955. His responsibilities will include the investigation of the utilization of forages by livestock.

Among the members of the Virginia Polytechnic Institute staff attending the meetings of the Association of Southern Agricultural Workers at Louisville, Kentucky, from the seventh through the ninth of February was Dr. E. P. Johnson, of the Animal Pathology Section, who was a guest speaker at the Poultry Section of the Association on the subject "A Vaccination Program for the Prevention of Avian Respiratory Diseases."

At the same session a paper by Alexander Harris, Clayton E. Holmes, and James H. Bywaters on "The Usefulness of Grit for Broilers" was presented by Dr. Bywaters. Dr. Bywaters was elected Secretary of the Poultry Section for 1956.

—WESLEY P. JUDKINS, *Virginia Polytechnic Institute.*

#### BIOLOGY SECTION

Hudnall R. Croasdale, a native of Reedville, Virginia, has joined the Virginia Fisheries Laboratory staff at Gloucester Point to assist in the study of migratory finfish. Mr. Croasdale served in the Army from 1952 to March, 1954. He was in the Navy during 1945 and 1946. A graduate of the University of Virginia in 1951, Croasdale had previously attended Virginia Polytechnic Institute. Since his release from the Army he has been engaged in commercial fishing. Mr. Croasdale, his wife, and son are now making their home at Gloucester Point.

Clarence E. Richards, Biologist from Concord, New Hampshire, has joined the Virginia Fisheries Laboratory to assist William H. Massmann and others in determining the causes in the fluctuation of abundance of some of our more important migratory fish. Richards is a recent graduate of the Wildlife Conservation School at Virginia Polytechnic Institute and is a member of the Wildlife Society of America. He graduated from Concord High School in June 1945 and was a member of the Army Air Force from then until 1946. He received his B.S. degree from the University of New Hampshire in 1951, Biology and Forestry being his major subjects.

Mr. William L. Mengebier, formerly professor of biology at the Citadel, has been appointed chairman of the biology department at Madison College. Mr. Mengebier received a B.S. degree from the Citadel, M.S. from Oberlin, and Ph.D. from the University of Tennessee. Mr. Mengebier began his duties at Madison in the fall of 1954.

Longwood College and Madison College announce the inauguration of a graduate program of study. Longwood will offer a course in evolution in the summer session of 1955 with Mr. George W. Jeffers as instructor. Madison offers *Vertebrae Ecology* by Mr. Mengebier and *Major Diseases of Man* by Mr. Shawver for the 1955 summer session.





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The following University of Virginia graduate students are now located at the institutions indicated:

Mr. Robert Amy, Susquehanna University

Mr. John Davis, Washington and Lee University

Miss Harriet Farrier, Department of Neurology and Psychiatry, University of Virginia Medical School

Mr. Donald Foard, Longwood College

Miss Nancy Groseclose, Agnes Scott College

Mr. James Larimer, Duke University

Miss Mary Jo Parrish, Mary Washington College

Miss Jean Pugh, Norfolk Division, College of William and Mary and Virginia Polytechnic Institute

Miss Pollyanna Martin of Lynchburg, a senior at Longwood College, recently became the bride of Mr. Donald E. Foard, research assistant at Longwood. Mr. and Mrs. Foard are living in Farmville.

—ROBERT T. BRUMFIELD, *Longwood College*

#### ENGINEERING SECTION

Dr. Lawrence R. Quarles, Assistant Dean of the University of Virginia School of Engineering, became a charter member of the American Nuclear Society which was organized in October, 1954.

Mr. Tilton E. Shelburne and Mr. Phillip E. Melville of the Virginia Council of Highway Investigation and Research attended the annual meeting of the Highway Research Board in Washington, D. C. in January, 1955. Mr. Shelburne also attended the meeting of the American Association of State Highway Officials, Highway Transport Committee, where final plans for a highway test road in Illinois were formulated. Mr. Phillip Melville presented a paper, "Concrete Aggregate Reaction in Virginia" at the annual symposium on geology at Johns Hopkins University, Baltimore, Maryland. Mr. Melville also attended a meeting of the American Concrete Institute in Milwaukee, Wisconsin.

Dr. Nelson F. Murphy, Department of Chemical Engineering, Virginia Polytechnic Institute, presented a paper "Mass Transfer in a Horizontal Liquid-Liquid Extraction Tube" at the annual meeting of the American Institute of Chemical Engineers in New York in December, 1954.

Dr. Dale F. Davis, Department of Chemical Engineering, Virginia Polytechnic Institute, recently published papers entitled "Fire Protection in the Paper Industry" in the November issue of *Paper Industry*; "A New Flexibility Test for Rubber," in the December *Rubber Age*; and "Specific Heats of Fluids," in the January issue of *Chemical Engineering*.

Professor Dan H. Pletta of the Department of Applied Mechanics, Virginia Polytechnic Institute, is editor of the *Engineering Mechanics Division Newsletter*, published by the American Society of Civil Engineers.

Professor W. A. Murray of the Electrical Engineering Department, Virginia Polytechnic Institute, was elected second vice-president of the Blacksburg chapter of the American Society of Professional Engineers.

—ROBERT M. HUBBARD, *University of Virginia*.



## GEOLOGY SECTION

The Virginia Division of Geology is co-sponsoring with the Appalachian Geological Society and the West Virginia Geological Survey a Spring Field Conference in the Harrisonburg, Virginia, area on May 20, 21, and 22. The conference will be devoted to a study of the older "Paleozoics" and basement complex of the northern Appalachians. All who plan to participate in the conference should indicate their intention by letter to William M. McGill or Robert S. Young, Virginia Division of Geology, Box 3667, University Station, Charlottesville, Virginia, on or before April 15.

Mr. W. T. Parrott, of the Virginia Department of Highways, reports that the results of a statewide aggregate survey, published as "Physical Test Results of the Virginia Highway Statewide Aggregate Survey," has created a great deal of interest in geological and engineering circles. The booklet is a compilation of tests on more than 2,000 samples of stone and aggregate which were collected over a six-year period. Mr. Parrott also reports a successful meeting of geologists and engineers at the Sixth Annual Symposium on Geology held at Johns Hopkins University on February 18th.

Of much interest to the members of the Geology section is the recent publication "Geology and Oil Resources of the Jonesville District, Lee Co., Virginia" by Ralph L. Miller and William P. Brosge. This report, U. S. G. S. Bull. 990, was prepared in cooperation with the Virginia Geological Survey. The Bulletin may be obtained from the Superintendent of Documents, Washington, 25, D. C.

The Geology Department of Virginia Polytechnic Institute has nearly completed a new thin-sectioning laboratory which includes an automatic feed diamond saw and three laps. C. E. Sears

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recently demonstrated to members of the Holden Society of Virginia Polytechnic Institute the use of a Ruska magnetometer and also the use of a sun compass. Byron N. Cooper gave a talk on industrial limestones of Virginia at the AIME meeting in Chicago, February 14-17. He also participated in a symposium on carbonate rocks held at the University



of Michigan, February 12. His paper dealt with the origin of Appalachian dolomites.

"Silica Sand Resources of Western Virginia" is the title of a paper which has been issued as Bulletin No. 96 of the Virginia Engineering Experiment Station. The bulletin was prepared by W. D. Lowry.

—W. D. LOWRY, *Virginia Polytechnic Institute*.

#### STATISTICS SECTION

Dr. Boyd Harshbarger, Head of the Department of Statistics at Virginia Polytechnic Institute, will be teaching Design of Experiments at the Southern Regional Graduate Summer Session which will be held at the University of Florida in Gainesville, Florida.

Dr. R. A. Bradley will return to his position as Professor of Statistics at the Virginia Polytechnic Institute on June 1, 1955. He has been a visiting professor at Rutgers University.

Dr. Robert E. Serfling of the Department of Health, Education, and Welfare presented a paper to a joint seminar of the Biology and Statistics Departments of Virginia Polytechnic Institute. His topic was "The Place of Statistics in Public Health Research."

Dr. P. N. Somerville resigned his position as Associate Professor at Virginia Polytechnic Institute April 1 to accept a position at the American University in Washington, D. C.

Paul C. Cox of White Sands Proving Ground and Robert Richards of the Redstone Arsenal will present seminars during the spring quarter at Virginia Polytechnic Institute.

Dr. W. A. Thompson of the Virginia Polytechnic Institute will publish a paper, "The Ratio of Variances in a Variance Components Model," in the June issue of the *Annals of Mathematical Statistics*.

—LIONEL WEISS, *University of Virginia*

# Virginia Academy of Science

## *P r o g r a m*

OF THE

### *Thirty-Third Annual Meeting*

AT MADISON COLLEGE

HARRISONBURG, VIRGINIA



MAY 11, 12, 13, 14, 1955

Host to Meeting

Madison College

## *Virginia Academy of Science*

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***General Program of  
The Thirty-Third Annual Meeting***

**1955**

WEDNESDAY, MAY 11

5:00 P.M. to 10:00 P.M.—Registration for Junior Academy Members, Participants in the Science Talent Search—Foyer, Madison Memorial Library.

5:00 P.M. to 10:00 P.M.—Arranging Exhibits—Burruss Science Hall.

THURSDAY, MAY 12

8:00 A.M. to 5:00 P.M.—Registration for Junior Academy Members, Senior Academy Members and Guests—Foyer, Madison Memorial Library.

9:00 A.M.—Meeting of Science Exhibit Judges, Science Talent Search Judges—Burruss Science Hall, Rooms 201, 209.

9:30 A.M.—Meeting of Chairman and Exhibitors, and Science Talent Search Participants—Burruss Science Hall, Room 109.

10:00 A.M. to 12:30 P.M. and 1:30 P.M. to 4:00 P.M.—Finalists of Talent Search meet with Chairman and Interviewers—Burruss Science Hall, Rooms 2, 7, 307, 308.

10:00 A.M. to 12:30 P.M. and 1:30 P.M. to 4:00 P.M.—Judging of Science Exhibit Contests—Burruss Science Hall .

1:00 P.M. to 2:00 P.M.—Luncheon.

2:00 P.M.—Meeting of the Council of the Academy—Burruss Science Hall, Room 103.

4:00 P.M.—Meeting of all Senior Academy Section Officers—Burruss Science Hall, Room 109.

4:30 P.M.—Meeting of the Section Editors—Burruss Science Hall, Room 209.

5:00 P.M.—Meeting of Virginia Junior Academy of Science Committee—Burruss Science Hall, Room 11.

7:00 P.M.—Business Meeting, Junior Academy of Science—Wilson Hall, Auditorium.

7:30 P.M.—Address of Guest Speaker for Junior Academy Members and Guests—Wilson Hall, Auditorium.

8:30 P.M.—Senior Academy Conference and General Meeting—Wilson Hall, Auditorium.

## FRIDAY, MAY 13

8:30 A.M.—Registration.

9:00 A.M.—Section Meetings: (See detailed sectional programs below for exact hour.)

Agricultural Sciences—Wilson Hall—Room 28

Astronomy, Mathematics, Physics—Burruss Science Hall—Room 11

Bacteriology—Burruss Science Hall—Room 311

Biology—Burruss Science Hall—Room 109

Chemistry—Wilson Hall—Auditorium

Education—Wilson Hall—Room 27

Engineering—Burruss Science Hall—Room 201

Geology—Burruss Science Hall—Room 209

Medical Sciences—Wilson Hall—Room 25

Psychology—Wilson Hall—Rooms 21 and 32

Science Teachers—Burruss Science Hall—Room 103

Statistics—Burruss Science Hall—Room 301

10:00 A.M. to 11:30 A.M.—Symposium, "What's New in Chemistry," sponsored by Science Teachers Section—Burruss Science Hall, Room 103.

12:00 noon to 1:00 P.M.—Junior-Senior Scientist Hour *at which awards will be presented*—Wilson Hall, Auditorium.

1:00 P.M. to 2:00 P.M.—Luncheon.

2:00 P.M.—Section Meetings.

4:45 P.M. to 6:00 P.M.—Madison College will be host at a tea to the Members and Guests of the Academy—Alumnae Hall Parlor.

7:45 P.M.—Short Business Meeting, Senior Academy—Wilson Hall, Auditorium.

8:30 P.M.—Address by Mr. Jerome Namias, Chief, Extended Forecast Section. U.S. Weather Bureau—Wilson Hall, Auditorium.

## SATURDAY, MAY 14

9:00 A.M.—Section Meetings.

10:00 A.M.—Academy Council Meeting—Burruss Science Hall, Room 103.

## *Section of Agricultural Sciences*

RODNEY C. BERRY, *Chairman*

R. W. ENGEL, *Vice-Chairman*

PAUL M. REAVES, *Secretary*

WESLEY P. JUDKINS, *Section Editor*

FRIDAY, MAY 13, 1955—9:00 A.M.—ROOM 28, WILSON HALL

9:00 Announcements, Committee Appointments, etc.

1. 9:15 Forage-Grain Substitution Rates in Milk Production Considered Further.  
Carl W. Allen; *Virginia Agricultural Experiment Station.*
2. 9:30 Soil Factors Affecting the Availability of Manganese for Peanuts.  
C. I. Rich; *Virginia Agricultural Experiment Station.*
3. 9:45 Crop Response to Various Rotations in the Peanut-Producing Area of Virginia.  
D. L. Hallock and L. I. Miller; *Virginia Agricultural Experiment Station.*
4. 10:00 Seedling Injury in Treated Wheat.  
James W. Midyette, Jr.; *Virginia Department of Agriculture.*
5. 10:15 Preliminary Observations on the Value of a Low Calcium-High Phosphorus Diet for the Prevention of Milk Fever in Dairy Cows.  
W. A. Hardison, G. A. Miller, R. A. Sandy, and G. C. Graf; *Virginia Agricultural Experiment Station.*
- 10:30 Recess.
6. 10:45 Crop Response to Rock Phosphate on Virginia Soils.  
W. W. Moschler; *Virginia Agricultural Experiment Station.*
7. 11:00 Sulfur Content of the Precipitation in Virginia.  
J. A. Lutz, Jr.; *Virginia Agricultural Experiment Station.*
8. 11:15 Progress Report on the Use of V-C 13 for the Control of Nematodes Infesting Turf Grasses.  
M. A. Manzelli; *Virginia-Carolina Chemical Corporation.*
9. 11:30 Application of Soil Survey to Certain Land Use Programs in Fairfax County.  
H. C. Porter; *Soil Survey, Virginia Agricultural Experiment Station.*
10. 11:45 The Use of Sex Hormones for Fattening Lambs.  
W. S. Wilkinson; *Virginia Agricultural Experiment Station.*



12:00 Noon — 1:00 P.M.—Junior-Senior Scientist Hour—Wilson Hall Auditorium.

FRIDAY, MAY 13, 1955—1:30 P.M.

11. 1:30 Observations on the Physiology of the Bovine Digestive Tract with Special Reference to Organ Activity.  
W. E. C. Moore and K. W. King; *Virginia Agricultural Experiment Station*.
12. 1:45 *In Vitro* Estimation of the Cellulolytic Activity of Rumen Ingesta.  
S. E. Wood and W. E. C. Moore; *Virginia Agricultural Experiment Station*.
13. 2:00 Freezing Bovine Semen.  
Paul M. Reaves, R. B. Potts, and E. A. Drinkwater; *Virginia Polytechnic Institute*.
14. 2:15 Variety, Type, Location and Yearly Effects on the Chemical Composition of Peanuts.  
J. F. Eheart, R. W. Young, and Allen H. Allison; *Virginia Agricultural Experiment Station*.
- 2:30 Recess.
15. 2:45 Factorial Experiments Give Valuable Information on How to Fertilize in Virginia.  
R. K. Stivers, P. T. Gish, G. D. Jones, and Boyd Harshbarger; *Virginia Agricultural Experiment Station*.
16. 3:00 Control of the Sting Nematode on Peanuts with an Ethylene Dibromide-Vermiculate Mixture.  
Lawrence I. Miller; *Virginia Agricultural Experiment Station*.
17. 3:15 Highly Chlorinated Naphthalene Studies in the Rat and the Calf.  
B. E. Joyce, W. B. Bell, and R. W. Engel; *Virginia Agricultural Experiment Station*.
18. 3:30 Growth Hormone Concentration in Swine Pituitaries.  
Bryan Baker; *Virginia Agricultural Experiment Station*.
19. 3:45 Changing Concepts in Milk Sanitation.  
G. S. Kennedy; *Roanoke Health Department*.
- 4:00 Business Session.

## *Section of Astronomy, Mathematics, and Physics*

H. Y. LOH, *Chairman*

J. GORDON STIPE, JR., *Acting Secretary*

F. L. HEREFORD, *Section Editor*

FRIDAY, MAY 13, 1955—10:00 A.M.—ROOM 11  
BURRUSS SCIENCE HALL

1. 10:00 Scattering of 200 Kev Electrons in Gold Foils.  
W. G. Pettus, H. G. Blosser, and F. L. Hereford; *University of Virginia*.
2. 10:15 Temperature Effects in the Annihilation of Positrons.  
R. T. Wagner and F. L. Hereford; *University of Virginia*.
3. 10:30 Design of the V. P. I. 1.5 Mev Pressurized Electrostatic Accelerator.  
T. M. Hahn; *Virginia Polytechnic Institute*.
4. 10:45 Two-photon Stokes Parameters.  
Stephen Berko; *University of Virginia*.
5. 11:00 Quenching of the Anomalous Lifetime Component of Positron Annihilation in Organic Compounds by Free Radicals.  
A. J. Zuchelli and S. Berko; *University of Virginia*.
6. 11:15 Positron Annihilation Lifetime in Semiconductors.  
Hugh S. Landes and S. Berko; *University of Virginia*.
7. 11:30 A New Fast Triple Coincidence Circuit Using Secondary Emission Tubes.  
Herbert O. Funsten and S. Berko; *University of Virginia*.
- 11:45 Business Meeting.
- 12:00 Noon - 1:00 P.M.—Junior-Senior Scientist Hour—Wilson Hall Auditorium.

FRIDAY, MAY 13, 1955—2:00 P.M.

8. 2:00 Closed Expressions for Two Trigonometric Series.  
Marvin Stippes; *Virginia Polytechnic Institute*.
9. 2:15 The Stieltjes Integral in n-Dimensional Space.  
E. J. McShane; *University of Virginia*.
10. 2:30 Motions and Distribution of Red Dwarf Stars.  
George Mumford; *University of Virginia*.
11. 2:45 Electrodeless Discharge through Gases at Low Frequencies.  
Paul S. Nekrasov and H. Y. Loh; *Virginia Polytechnic Institute*.

12. 3:00 Reflected Fringes of Multiples-beam Interference.  
H. Y. Loh; *Virginia Polytechnic Institute*.
13. 3:15 Diffusion Fields to Growing Crystal Surfaces.  
Marvin M. Levine; *University of Virginia*. (Introduced by N. Cabrera.)
14. 3:30 Lattice Relaxations around Lattice Imperfections.  
George Hall; *University of Virginia*. (Introduced by N. Cabrera.)
15. 3:45 Surface Energy of Metals.  
Robert McIntyre; *University of Virginia*. (Introduced by N. Cabrera.)
16. 4:00 Interference Fringes of Beats Investigated with Superposed Transparencies.  
L. G. Hoxton; *University of Virginia*.
17. 4:15 Infra-Red Dispersion in the Region of Absorption Bands.  
Melvin A. Pittman; *Madison College*.

## *Section of Bacteriology*

H. J. WELSHIMER, *Chairman*

W. F. LAWRENCE, *Vice-Chairman*

MILES G. BOWLES, *Secretary*

J. DOUGLAS REID, *Section Editor*

SATURDAY, MAY 14, 1955—11:00 A.M.—ROOM 311

NEW SCIENCE BUILDING

11:00 A.M. Business Meeting.

SATURDAY, MAY 14, 1955—1:30 P.M.

1. 1:30 Some Problems in the Simplification of *Endamoeba histolytica* Cultivation Medium.  
E. Clifford Nelson and Muriel M. Jones; *Medical College of Virginia*.
2. 1:45 Contamination in Bank Blood.  
A. Rosensweig; *McGuire Veterans Hospital*, Richmond.
3. 2:00 Serological Studies of *Lactobacilli*.  
P. Arne Hansen and R. H. Miller; *University of Maryland*.
4. 2:15 An Unusual, Small, Gram Positive Rod Isolated From Spinal Fluid.  
Herbert J. Welshimer; *Medical College of Virginia*.



5. 2:30 A Comparison of the Original Loewenstein Media with Jensen's Modification of Loewenstein in the Culture of *Mycobacterium tuberculosis*.  
William A. Dorsey and Jo Soles; *Department of Public Health, Richmond*.
6. 2:45 Human Tissues in Tissue Cultures.  
A. E. Feller; *School of Medicine, University of Virginia*.
7. 3:00 A Study on Some Racial Differences with Respect to Tuberculosis.  
Margaret S. Anderson; *Madison College*.
8. 3:15 The Tuberculostatic Activity of Aqueous Extracts Prepared from Selected Mammalian Tissues.  
Quentin N. Myrvik; *School of Medicine, University of Virginia*.

### *Section of Biology*

ROSCOE HUGHES, *Chairman*

JACQUES RAPPAPORT, *Vice-Chairman*

JACK D. BURKE, *Secretary*

ROBERT T. BRUMFIELD, *Section Editor (1957)*

FRIDAY, MAY 13, 1955—9:30 A.M.—ROOM 109

BURRUSS SCIENCE HALL

- 9:30 Announcements—Committee reports.
1. 9:40 The Inheritance of Fruit-shape in *Cucurbita moschata*.  
A. M. Showalter; *Madison College*.
2. 10:00 The Development of the Ovule, Megasporogenesis, and Megagametogenesis in *Typha angustifolia*.  
Philip E. Graef; *University of Virginia*.
3. 10:10 Certain Bryophytes with Critical Distribution in Virginia.  
Paul M. Patterson; *Hollins College*.
4. 10:20 Observations on the Effects of Eyestalk Extirpation on the Female Crayfish, *Cambarus longulus longulus*, Girard.  
Elizabeth M. Zipf; *University of Virginia*.
5. 10:30 Growth of Oysters at Gloucester Point, Virginia.  
J. L. McHugh; *Virginia Fisheries Laboratory*.
6. 10:40 *Betula uber* (Ashe) Fernald in Smyth County, Virginia.  
A. B. Massey and L. R. Hundley; *Virginia Polytechnic Institute*.

7. 10:45 A Tendency Toward Cyclic Dimorphism in Female Crayfishes.  
Horton H. Hobbs, Jr.; *University of Virginia*.
- 10:55 Business Meeting.
- 12:00 Noon — 1:00 P.M.—Junior-Senior Scientist Hour—Wilson Hall Auditorium.

## FRIDAY, MAY 13, 1955—1:30 P.M.

8. 1:30 Liver Restoration in the Golden Hamster After Partial Hepatectomy—Preliminary Report.  
William L. Mengebier, Antonina Skapars, Oliver Henderson; *Madison College* and *Texas A. and M. College*.
9. 1:40 A Preliminary Report on Observations of the Effects of Eye-Extirpation on Testicular Behavior in the Crayfish.  
Sam R. Telford, Walter H. Lewis, and John B. Kayan; *University of Virginia*.
10. 1:50 The Somatic Chromosomes of *Tulbaghia*.  
W. S. Flory, Jr.; *University of Virginia*.
11. 2:00 Alternanthera in Virginia.  
A. B. Massey; *Virginia Polytechnic Institute*.
12. 2:05 Chromosome Numbers of Some Species and Hybrids in the Araceae.  
Gertrude Earl; *University of Virginia*.
13. 1:15 Water Content of Vertebrate Embryos and Larvae.  
A. M. Showalter and Harry Ruebush; *Madison College*.
14. 2:25 Monoecious Tendencies in the Crayfish, *Cambarus longulus longulus*, Girard.  
W. H. Lewis; *University of Virginia*.
15. 2:35 Chromosome Complements of Some *Cyrtanthus* Species in Subgenus Monella Compared with that of *C. sanguineus* in Subgenus Gastronema.  
W. S. Flory, Jr.; *University of Virginia*.
16. 2:45 Oxygen Capacity Studies in Relation to Body Weight in Albino Rats.  
Jack D. Burke; *University of Richmond*.

## SATURDAY, MAY 14, 1955— 9:00 A.M.

Field Trip—Assemble at main entrance of Burruss Science Hall.

## Section of Chemistry

J. STANTON PIERCE, *Chairman*  
RICHARD M. IRBY, JR., *Secretary*  
CARL J. LIKES, *Section Editor*

FRIDAY, MAY 13, 1955—9:00 A.M.—AUDITORIUM, WILSON HALL

- 9:00 Introductory Remarks by the Chairman.
1. 9:10 The Effects of Various Considerations on the Air Flow through a Cigarette.  
P. M. Pedersen and E. S. Harlow; *Richmond*.
  2. 9:30 X-Ray Photoelectron Spectrometry.  
Ralph G. Steinhardt, Jr.; *Virginia Polytechnic Institute*.
  3. 9:55 An X-Ray and Metalographic Study of Large Grain Titanium.  
Francis J. Dennis; *Virginia Institute for Scientific Research*.
  4. 10:10 Acid and Base Combining Capacity of Zein.  
Carl J. Likes and Donald F. Koenig; *Virginia Institute for Scientific Research*.
  5. 10:20 Sulfur and Nitrogen Compounds as Antioxidants at Elevated Temperatures.  
James W. Cole, Donald R. Campbell, and Robert N. Lawhorn; *University of Virginia*.
  6. 10:35 An Improved Smoking Automaton.  
Robert C. Lieser and Andrew E. O'Keeffe; *Research Department, Phillip Morris and Company, Ltd., Inc.*
  7. 10:50 Electrochemical Preparation of Boron.  
Nelson F. Murphy, Richard J. Tinsley and George F. Meenaghan; *Virginia Polytechnic Institute*.
  8. 11:05 Systematic Chromatographic Analysis For Metals.  
Harriett H. Fillinger; *Hollins College*.
  9. 11:15 Guest Lecture—Fundamental Research and the Tobacco Industry.  
E. S. Harlow; *Coordinator of Research, Research Laboratory, The American Tobacco Company*.
- 12:00 Noon — 1:00 P.M.—Junior-Senior Scientist Hour—Wilson Hall Auditorium.



FRIDAY, MAY 13, 1955—1:50 P.M.

- 1:50 Business Meeting.
10. 2:00 Determination of Trace Quantities of Nickel in Human Blood.  
Maxwell L. Cluett and John H. Yoe; *Pratt Trace Analysis, University of Virginia.*
11. 2:15 Spectrophotometric Determination of Trace Quantities of Magnesium.  
Charles K. Mann and John H. Yoe; *Pratt Trace Analysis Laboratory, University of Virginia.*
12. 2:30 Two New Colorimetric Reagents for the Determination of Boron.  
Robert L. Grob and John H. Yoe; *Pratt Trace Analysis Laboratory, University of Virginia.*
13. 2:45 An Apparatus for the Study of Ignition and Mass Transfer of Droplet Vapor Systems.  
W. E. Rice and S. S. Stein; *Experiment Incorporated.*
14. 3:00 The Experimental Determination of Burning Velocity by the Bunsen Burner Technique.  
George J. Gibbs and Hartwell F. Calcote; *Experiment Incorporated.*
15. 3:15 Studies of Ionization in Flames by Means of Langmuir Probes.  
I. R. King and Hartwell F. Calcote; *Experiment Incorporated.*
16. 3:30 A New Technique for Studying Dust Explosions.  
Lloyd E. Line, Jr. and Wendall J. Clark.
17. 3:45 Some Reactions of Butadiene Cyclic Sulfone.  
Robert C. Krug and George R. Tichelaar; *Virginia Polytechnic Institute.*
18. 4:00 Halogenated Isoprenic Cyclic Sulfones.  
Robert C. Krug and Teh-Fu Yen; *Virginia Polytechnic Institute.*
19. 4:15 Chromatographic Separation of a Complex Polynuclear Hydrocarbon Mixture.  
Frank A. Vingiello and Alexej B. Borkovec; *Virginia Polytechnic Institute.*
20. 4:35 Some Macrocyclic Chemistry.  
Albert W. Lutz; *William and Mary.*
21. 4:45 A Submerged Combustion Boiler.  
Gerald Golub; *Experiment Incorporated.*

SATURDAY, MAY 14, 1955—9:00 A.M.

AUDITORIUM, WILSON HALL

1. 9:00 Thermodynamics of Complex Ion Formation.  
Loren G. Hepler; *University of Virginia*.
2. 9:15 The Study of Films on Catalytic Surfaces With the Aid of Elliptically Polarized Light.  
Robert E. Cunningham and Fred W. Young, Jr.; *University of Virginia*.
3. 9:25 The Rates of Oxidation of Several Faces of Copper With the Aid of Elliptically Polarized Light.  
F. W. Young; *University of Virginia*.
4. 9:55 Studies of the Coordination of 1,3-bis-(tris-(hydroxymethyl))-methylamino-2-propanol With Some Cations of the First Transition Series.  
Velta Erdmanis and William E. Trout, Jr.; *University of Richmond*.
5. 10:10 A Further Study of Fe (III) and 1,3-bis-(tris-(hydroxymethyl))-methylamino-2-propanol.  
Jane Bell Gladding and William E. Trout, Jr.; *University of Richmond*.
6. 10:25 The Oxidative Determination of Humectant Additives in Tobacco.  
H. E. Wright, Jr. and W. W. Burton; *Research Laboratory, The American Tobacco Company*.
7. 10:40 Comparisons of Zein Textile. Fibers with Fine Clothing Wool.  
George L. Walker; *Research Department, Virginia Carolina Chemical Corporation*.
8. 10:55 Synthesis and Chemistry of O-2, 4-Dichlorophenyl O, O-Diethyl Phosphorothioate ("V-C 13 Nemacide) and Its Analogs.  
Charles L. Harowitz; *Research Department, Virginia Carolina Chemical Corporation*.
9. 11:10 The Determination of Residues of O-2, 4-Dichlorophenyl O, O-Diethyl Phosphorothioate ("V-C 13 Nemacide).  
George R. Boyd; *Research Department Virginia-Carolina Chemical Corporation*.
10. 11:25 Preparation of Some New Aromatic Ketones.  
Frank A. Vingiello and J. Robert Thornton; *Virginia Polytechnic Institute*.
11. 11:35 The Preparation of Some Methyl- and Trichloromethyl-O-benzylphenylcarbinols.  
Frank A. Vingiello and Peter E. Newallis; *Virginia Polytechnic Institute*.

12. 11:45 Trityl Ethers of Negatively Substituted Alcohols.  
J. S. Belew, J. O. Edwards, (*Brown University*) and R. Layton; *University of Virginia*.

## *Section of Education*

JACK H. BOGER, *Chairman*  
DEFOREST L. STRUNK, II, *Secretary*  
JAMES PATTON, *Section Editor*

FRIDAY, MAY 13, 1955—9:00 A.M.—ROOM 27, WILSON HALL

1. 9:00 An Application of the Informal Reading Inventory.  
Katherine Minor Anthony; *Madison College*.
  2. 9:20 The New Science.  
Winfred P. Elson; *Calverton, Virginia*.
  3. 9:40 The Prediction of Achievement in High School Biology.  
Alonzo M. Myster and Emily Murdock; *Statistical Laboratory, Virginia State College*.
  4. 10:00 Comparison of Individual and Small Group Method of Laboratory Instruction in General College Chemistry.  
W. Donald Clague; *Bridgewater College*.
  5. 10:20 A Project in the Cooperative Production of Instructional Guides for Teachers of Science.  
John B. Chase; *University of Virginia*.
  6. 10:50 A Study in the Cooperative Improvement of the Quality of Educational Experiences in the Laboratory School of Longwood College.  
Helen R. McDowell; *Longwood College*.
  7. 11:20 An Analysis of the True Value Factor in the Formula for the Calculation of the Distribution Monies from the Minimum Educational Program Fund and the Salary Equalization Fund of the Virginia State Department of Education with Particular Reference to Northampton County.  
Paul G. Watson; *Cape Charles High School*.
  8. 11:50 A Preliminary Investigation in the Teaching of College Biology.  
Mary H. Richardson; *Stratford College*.
- 12:00 Noon — 1:00 P.M.—Junior-Senior Scientist Hour—Wilson Hall Auditorium.



FRIDAY, MAY 13, 1955—1:45 P.M.

9. 1:45 The Construction of a Scale for the Measurement of Attitudes Towards Science in the Elementary Schools and Towards Mathematics in the Junior High Schools.  
Alonzo M. Myster, Lillian Banks, and Doris M. Wood;  
*Statistical Laboratory, Virginia State College.*
10. 2:15 Panel Discussion of "The Manpower Shortage in the Scientific Fields and the Implications for Science Education in the Public Schools".  
Panel Members: Jack H. Boger, *Richmond Public Schools*; J. W. Cole, *University of Virginia*; Alfred Wingo, Supervisor of Research, *State Department of Education*, and Alex Saddle, *Allied Chemical and Dye Corporation, Hopewell.*
- 3:15 Business Meeting.

## Section of Engineering

PHILLIP L. MELVILLE, *Chairman*DUDLEY TOMPSON, *Secretary*ROBERT M. HUBBARD, *Section Editor (1958)*FRIDAY, MAY 13, 1955—9:00 A.M.—ROOM 201  
BURRUSS SCIENCE HALL

- 9:00 Opening Remarks—P. L. Melville, *Chairman.*
1. 9:15 Investigation of Slotted and Perforated Transonic Nozzles.  
R. W. Truitt and Arthur C. Bruce; *Virginia Polytechnic Institute.*
2. 9:35 A New Method of Accident Analysis and Its Application to Highway Engineering.  
Alfred Vick, III; *Virginia Department of Highways.*
3. 10:00 Let's Take the "Burgers" out of Control Systems.  
B. A. Niemeier; *Consulting Engineer, Richmond.*
4. 10:25 Model Studies of Prestressed Concrete Beams Used in the Hampton Roads Approach Bridges.  
Ignacio Romero; *Virginia Council of Highway Investigation and Research.*
5. 10:50 A Study of Highway Sign Legibility.  
Terrence M. Allen; *Virginia Council of Highway Investigation and Research.*

6. 11:15 Schlieren Photography, High Brilliance Light Source.  
Orville R. Harris; *University of Virginia*.
7. 11:35 Theory of Free Streamlines in Compressible Flow.  
Robert W. Truitt; *Virginia Polytechnic Institute*.
- 12:00 Noon — 1:00 P.M.—Junior-Senior Scientist Hour—Wilson  
Hall Auditorium.

## FRIDAY, MAY 13, 1955—1:30 P.M.

8. 1:30 A Study of Variables Affecting Chemical Control of Shrubs  
on Power Line Right-of-Ways in Southwest Virginia.  
Herbert P. Olson and Frank C. Vilbrandt; *Virginia Poly-  
technic Institute*.
9. 1:50 Calculations of Individual, Mass-Transfer Coefficients for  
Two-Phase, Liquid Extraction Systems.  
John E. Lastovica and Nelson F. Murphy; *Virginia Poly-  
technic Institute*.
10. 2:10 Characteristics of Sieve Plates for Contacting Liquid and  
Vapor.  
James I. Lankford; *University of Virginia*.
11. 2:30 Individual Dynode Voltage Regulator for Photomultiplier  
Tubes.  
B. d'E. Flagge and O. R. Harris; *University of Virginia*.
12. 2:50 Causes of Highway Sign Failure.  
Arthur L. Straub; *Virginia Council of Highway Investi-  
gation and Research*.
13. 3:10 An Investigation of the Properties of Various Gradations  
Meeting F-1, Sand-Asphalt, Specifications.  
P. E. McIntyre; *Virginia Council of Highway Investi-  
gation and Research*.
14. 3:30 Design and Construction of an Ultrasonic System for Study  
of Liquid-Liquid Extraction.  
Hughey Allen Woodle, Jr. and Dudley Thompson; *Vir-  
ginia Polytechnic Institute*.
15. 3:50 Use of Prestressed Concrete in the Hampton Roads Bridge  
Tunnel Project.  
J. N. Clary; *Virginia Department of Highways*.
- 4:10 Junior Academy Awards.
- 4:40 Business Session.

SATURDAY, MAY 14, 1955—9:30 R.M.—ROOM 201  
BURRUSS SCIENCE HALL

16. 9:30 A Study of Bond between Pretension Steel and Concrete in Prestressed Concrete.  
Charles E. Echols; *Virginia Council of Highway Investigation and Research.*
17. 9:50 An Analytical Method for Analyzing Hipped Plate Structures.  
Daniel Frederick, *Virginia Polytechnic Institute.*
18. 10:10 Atomic Explosion and Structural Stability.  
Henry L. Kinnier; *University of Virginia.*
19. 10:20 An Investigation of Wedges at Angle of Attack.  
R. W. Truitt and Robert D. Jones; *Virginia Polytechnic Institute.*
20. 10:40 A Semi-Instantaneous Rainfall Ratemeter.  
Leo F. Goeller; *University of Virginia.*
21. 11:00 The Design of a Pilot Plant for the Production of Maleic Acid Hydrazide.  
Willard Hall Sawyer and Frank C. Vilbrandt; *Virginia Polytechnic Institute.*
22. 11:20 Correlation of Soil Properties and Index Constants.  
C. Page Fisher, *Consulting Engineer, Richmond,* and William H. Vogelsang, *Chief Geologist, Froehling and Robertson, Inc., Richmond.*

### *Section of Geology*

WILLIAM T. HARNSBERGER, *Chairman*  
WILLIAM T. PARROTT, *Vice-Chairman*  
MARCELLUS H. STOW, *Secretary*  
W. D. LOWRY, *Section Editor (1958)*

FRIDAY, MAY 13, 1955—9:00 A.M.—ROOM 209,  
BURRUSS SCIENCE HALL

(Time for discussion will be allowed at end of each paper.)

1. 9:00 Title to be announced.  
Marcellus H. Stow; *Washington and Lee University.*
2. 9:10 Effect of Traffic Polishing on Limestone Aggregates.  
William T. Parrott; *Virginia Department of Highways*



3. 9:25 The Bergton-Crab Run Gas Field, Western Rockingham County, Virginia.  
R. S. Young and W. T. Harnsberger; *Division of Geology, Virginia Department of Conservation and Development*.  
(Presented by W. T. Harnsberger.)
4. 9:35 Monazite Deposits of Virginia.  
Charles E. Sears, Jr.; *Virginia Polytechnic Institute*.
5. 9:50 Current Manganese Operations in Virginia.  
E. O. Gooch; *Division of Geology, Virginia Department of Conservation and Development*.
6. 10:05 Origin of a Greenstone Conglomerate in the Charlottesville Vicinity.  
Robert M. Cordova; *University of Virginia*.
7. 10:20 A Peridotite Dike Near Front Royal, Virginia.  
Robert S. Young and Roy A. Bailey; *Division of Geology, Virginia Department of Conservation and Development*.  
(Presented by Robert S. Young).
8. 10:35 Geology of Southeastern Piedmont Virginia.  
A. A. Pegau and W. B. Brent; *Division of Geology, Virginia Department of Conservation and Development*.  
(Presented by A. A. Pegau).
9. 10:45 Are the Depressions of Major Synclines in the Valley and Ridge Province of Virginia of Depositional Origin?  
W. D. Lowry; *Virginia Polytechnic Institute*.
- 11:00 Announcements.
- 12:00 Noon — 1:00 P.M.—Junior-Senior Scientist Hour— Wilson Hall Auditorium.

FRIDAY, MAY 13, 1955—2:00 P.M.

(Time for discussion will be allowed at end of each paper)

10. 2:00 Is the Rockfish Conglomerate Intraformational?  
R. V. Dietrich; *Virginia Polytechnic Institute*.
11. 2:15 Ground Water in the Waynesboro Area, Virginia.  
Jack Lowden; *University of Virginia*.
12. 2:25 Preliminary Investigation of Fossils in the Arvonian Slate.  
Shelton P. Applegate; *University of Virginia*.
13. 2:35 Natural Chimneys of Augusta County, Virginia.  
C. C. Fisher; *Division of Geology, Virginia Department of Conservation and Development*.
14. 2:50 Heavy Mineral Correlation in Coastal Plain Sediments.  
Allen Sinnott, *U. S. Geological Survey*.

15. 2:55 Mineralogical Studies of Sediments from the Eastern Shore Peninsula of Virginia.  
Basil Doerhoefer, III, Thomas B. Neblett, Jr., Harold E. Sturgill, Robert S. Wood; *Washington and Lee University*. (Presented by Robert S. Wood.)
16. 3:05 Mineralogical Studies of Sediments from New River, Virginia.  
Charles A. MacIntosh, Alan R. Mixson, David K. Willard, Jr.; *Washington and Lee University*. (Presented by David K. Willard, Jr.)
17. 3:15 Mineralogical Studies of Sediments from Banister River, Virginia.  
Sam Berry, Douglas D. Monroe, Leroy H. Simkins, Jr.; *Washington and Lee University*. (Presented by Leroy H. Simkins, Jr.)
18. 3:25 Proposed New Systems of Soil Classification.  
G. H. Robinson and S. S. Obenshain; *U. S. Department of Agriculture and Virginia Polytechnic Institute*.
19. 3:35 Soil-Rock Relationships in Fairfax County, Virginia.  
J. F. Derting and H. C. Porter; *Virginia Agricultural Experiment Station*. (Presented by J. F. Derting.)
- 3:45 Business Meeting.

SATURDAY, MAY 14, 1955 — 8:30 A.M.

- 8:30 Field Trip: Lower and Middle Ordovician Stratigraphy, Middletown Quarry, M. J. Grove Lime Quarry and Mine.  
Leaders: C. E. Bass, B. N. Cooper, R. S. Edmundson, Paul Herbert, Robert S. Young.

(Place of assembling and details of trip to be announced during Friday meeting.)

## *Section of Medical Sciences*

SIDNEY SOLOMON, *Chairman*

GROVER C. PITTS, *Secretary*

EBBE C. HOFF, *Section Editor*

FRIDAY, MAY 13, 1955—10:00 A.M.—ROOM 25, WILSON HALL

1. 10:00 A Histochemical Study of Ribose Nucleic Acid in the Eye of the Chick Embryo.  
Morris S. McKeehan; *University of Virginia School of Medicine*.

2. 10:15 The Combination of Insulin with Frog Skeletal Muscle.  
D. R. H. Gourley; *University of Virginia School of Medicine.*
3. 10:30 Studies on the Activity of the Detrusor Muscle with Special Reference to the Effects of Electrical Stimulation of Fore-brain Structures.  
Everett H. Ingersoll, Louise L. Jones, and Erling S. Hegre; *Medical College of Virginia.*
4. 10:45 Serum Protein Patterns in Rabbits During Sensitization and Desensitization.  
Oscar Swineford, Cornelia Hoch-Ligeti, and Karen Irvine; *University of Virginia School of Medicine.*
5. 11:00 Motion Pictures of Cellular Changes in Tissues of Tadpoles After X-ray Irradiation as Recorded *in vivo*.  
Carl Caskey Speidel; *University of Virginia School of Medicine.*
6. 11:15 Further Studies on the Inhibition of Porphyrin Synthesis by Benzimidazole Derivatives.  
Lynn D. Abbott, Jr. and Mary J. Dodson; *Medical College of Virginia.*
- 11:30 Business meeting.
- 12:00 Noon — 1:00 P.M.—Junior-Senior Scientist Hour—Wilson Hall Auditorium.
7. 1:30 Studies by Paper Electrophoresis of Serum Lipoproteins.  
J. C. Forbes and P. C. Taylor; *Medical College of Virginia.*
8. 1:45 The Ultraviolet Absorption Spectra of Iodinated Proteins.  
Chalmers L. Gemmill; *University of Virginia School of Medicine.*
9. 2:00 Studies on Metabolites of Nicotine.  
Fletcher B. Owen and P. S. Larson; *Medical College of Virginia.*
10. 2:15 A Study of Defecation in the Cat.  
Roy L. Mundy and Eugene D. Brand; *University of Virginia School of Medicine.*
11. 2:30 Autonomic Effects of a New Series of Substituted Amines and Quaternary Ammonium Compounds.  
W. H. Pindell, J. K. Finnegan, and J. D. Smith; *Medical College of Virginia.*
12. 2:45 The Mechanism of Nitrogen Mustard-Induced Emesis in the Cat.  
Eugene D. Brand; *University of Virginia School of Medicine.*



## *Section of Psychology*

GILBERT J. RICH, *Chairman*

AUDREY M. SHUEY, *Secretary-Treasurer*

HENRY M. IMUS, *Executive Committeeman*

R. H. HENNEMAN, *Section Editor*

FRIDAY, MAY 13, 1955—9:30 A.M.—WILSON HALL

9:30-12:00 Noon

Program A—Room 21

Program B—Room 32

12:00 Noon — 1:00 P.M.—Junior-Senior Scientist Hour—Wilson Hall Auditorium.

1:30- 3:00 P.M.

Symposium A—Room 21

Training Programs for Psychologists in Virginia:  
Present Status and Future Plans

Symposium B—Room 32

The Role and Contributions of Clinical and Counselling Psychologists.

3:00- 5:00 P.M.

Business Meeting (including report of Committee on Evaluation of Functions.)

### PROGRAM A—ROOM 21, WILSON HALL

1. 9:00 Factors Determining the Proficiency of Multiple Task Performance.  
Glenn R. Hawkes; *University of Virginia.*
2. 9:20 Vibrotactile Communication and Training.  
William C. Howell; *University of Virginia.*
3. 9:40 The Influence of Varying Probabilities of Reinforcement in a Matching-to-Sample Situation with Humans.  
William E. Montague; *University of Virginia.*
4. 10:00 An Investigation of the Stimulus Dimensions in Vibratory "Phi".  
William H. Sumby; *University of Virginia.*
5. 10:20 Stereotypes and Perceptual Distortion.  
Linda Johnson; *Mary Washington College.*

6. 10:40 The Effect of Stimulus Reversal on Discrimination Chaining.  
Milton H. Hodge; *University of Virginia*.
7. 11:00 Visual Recognition Thresholds as Indices of Word Probabilities.  
William A. Lee; *University of Virginia*.
8. 11:20 The Retention of Responses to Specific Verbal Stimuli Compared with Retention of Responses to Classes of Verbal Stimuli.  
Kenneth E. Lloyd; *University of Virginia*.

## PROGRAM B—ROOM 32, WILSON HALL

1. 9:00 Criteria for Enrolling College Students in "Improvement of Reading Skills" Course.  
Frances Dean Scott; *Lynchburg College*.
2. 9:20 The Effects of Remedial Reading Upon California Mental Maturity Retest Scores.  
William P. Matthews; *Lynchburg College*.
3. 9:40 Disproportionate Contribution of Revised Beta Scales Scores to Total Scores in Adolescent Groups.  
Walter A. Woods and Robert Toal; *Richmond Professional Institute*.
4. 10:00 Intelligence Differences in Delinquents as Appraised by Four Psychological Tests.  
Walter A. Woods and John A. Farley; *Richmond Professional Institute*.
5. 10:20 Research Programs in Neurological Disease and Blindness.  
Henry A. Imus; *National Institute of Health*.
6. 10:40 The Measurement of Primary Mental Abilities by the Columbia Mental Maturity Scale.  
Jack H. Boger, Cyril R. Mill, and Charles J. Turner; *Richmond Public Schools*.
7. 11:00 Recent Research in Perception and Its Implications for Research with Projective Techniques.  
A. W. Jeffreys, Jr.; *Western State Hospital*.
8. 11:20 A Validity Study of the Morgan Test of Logical Reasoning in Terms of Career Employees for Government Service.  
William J. Morgan; *Aptitude Associates, Inc.*
9. 11:40 To Search for Evidence on the Popular Belief that Males Are More Logical in Their Reasoning Processes than Females.  
Antonia Bell Morgan; *Aptitude Associates, Inc.*

## *Section of Science Teachers*

G. L. THOMASSON, *Chairman*  
FRANKLIN D. KIZER, *Chairman-Elect*  
MARTHA W. DUKE, *Secretary*  
CAROLINE GAMBRILL, *Section-Editor*

FRIDAY, MAY 13, 1955—9:30 A.M.—ROOM 103  
BURRUSS SCIENCE HALL

THEME—"What's New in Chemistry"

- 9:30 Appointment of Nominating Committee.
1. 9:40 Biophysics.  
Sidney S. Negus; *Medical College of Virginia*.
  2. 10:10 Fibers and Fertilizers.  
W. T. Boyer; *Virginia-Carolina Corporation*.
  3. 10:40 Medical Chemistry.  
Speaker to be announced.
  4. 11:10 Trend in Science Teacher Supply.  
M. C. Shawver; *Madison College*.
- 11:40 Report of Nominating Committee.  
11:50 Adjournment.  
12:00 Noon-1:00 P.M. — Junior-Senior Scientist Hour — Wilson Hall Auditorium.

## *Section of Statistics*

M. C. K. TWEEDIE, *Chairman*  
C. Y. KRAMER, *Secretary*  
LIONEL WEISS, *Section Editor*

FRIDAY, MAY 13, 1955—9:00 A.M.—ROOM 301

- 9:00 Introductory Remarks of the Acting Chairman.
1. 9:10 Some Results on Recurrent Event Theory.  
John E. Freund; *Virginia Polytechnic Institute*.
  2. 9:30 A Property of the Balanced Incomplete Block Designs.  
W. A. Thompson, Jr.; *Virginia Polytechnic Institute*.
  3. 9:50 On Parameter Estimates Expressed as Sets of Values.  
M. C. K. Tweedie; *Virginia Polytechnic Institute*.



4. 10:10 On the Numeration of Consistent Pairwise Comparisons.  
R. L. Wine and John E. Freund; *Virginia Polytechnic Institute*.
5. 10:30 Intermission.
6. 10:40 Various Approaches in Evaluating Census Data.  
G. W. Suter; *Virginia Cooperative Crop Reporting Service*.
7. 11:00 Some Antecedents of Modern Experiment Design.  
Churchill Eisenhart; *National Bureau of Standards*.
- 12:00 Noon — 1:00 P.M.—Junior-Senior Scientist Hour—Wilson Hall Auditorium.

## FRIDAY, MAY 13, 1955—2:00 P.M.

8. 2:00 Business Meeting.
9. 2:30 Estimation of Aircraft Spare Parts Requirements.  
Walter Jacobs; *Department of the Air Force*.
10. 2:50 A Statistician Looks at the Employee Security Problem.  
Morris J. Solomon; *Bureau of the Census*.
11. 3:30 Intermission.
12. 3:40 Life Testing in the Discrete Case.  
F. S. McFeely; *Virginia Polytechnic Institute*.
13. 4:00 New Developments in Paired Comparisons.  
R. A. Bradley; *Virginia Polytechnic Institute*.
14. 4:20 Consistency of Subjective Scores in Non-Replicated Experiments.  
T. S. Russell; *Virginia Polytechnic Institute*.

## SATURDAY, MAY 14, 1955—9:00 A.M.—ROOM 301

## BURRUSS SCIENCE HALL

15. 9:00 Some Properties of Order Statistics from Discrete Uniform Distributions.  
E. L. Bombara; *Virginia Polytechnic Institute*.
16. 9:20 Sequential Procedures that Control the Individual Probabilities of Coming to the Various Decisions.  
Lionel Weiss; *University of Virginia*.
17. 9:40 Some Aspects of Quality Control.  
Donald J. Shaw; *E. I. duPont DeNmours and Company*.
18. 10:10 Intuitive Probability and Economic Behavior.  
Cleon Harrell; *University of North Carolina*.
19. 10:30 Intermission.

20. 10:40 A Result on Geary's Extension of Berkson's Case of Functional Relationships.  
H. C. Sweeny; *Virginia Polytechnic Institute*.
21. 11:00 Designs for Interblock Analysis.  
C. C. Beazley; *Virginia Polytechnic Institute*.
22. 11:20 A Study of the Use of an Auxiliary Variate in Analysing Discrete Data.  
R. J. Taylor and M. C. K. Tweedie; *Virginia Polytechnic Institute*.
23. 11:40 A Test of Consistency and Inconsistency in Subjective Ratings. (By Title)  
A. N. Pozner; *Virginia Polytechnic Institute*.

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### NOTICE TO CONTRIBUTORS

Contributions to the Journal should be addressed to Horton H. Hobbs, Jr., Miller School of Biology, University of Virginia, Charlottesville, Virginia. If any preliminary notes have been published on the subject which is submitted to the editors, a statement to that effect must accompany the manuscript.

Manuscripts must be submitted in triplicate, typewritten in double spacing on standard 8½" x 11" paper, with at least a one inch margin on all sides. Manuscripts are limited to seven pages, with the proviso that if additional pages are desired, the author may obtain them at cost.

Division of the manuscript into subheadings must follow a consistent plan, and be held to a minimum. It is desirable that a brief summary be included in all manuscripts.

Footnotes should be included in the body of the manuscript immediately following the reference, and set off by a dashed-line above and below the footnote content. Footnotes should be numbered consecutively from the beginning to the end of the manuscript.

Bibliographies (Literature Cited, References, etc.) should be arranged alphabetically according to author. Each reference should include the date, full title of the article, the name of the Journal, the volume, number (optional), pages, tables and figures (if any). For example: "Sniffen, Ernest W. 1940. Cobbles from the Pleistocene Terraces of the Lower York-James Peninsula, Va. Journ. Sci., 1 (8): 285-288, 1 fig. 1 tab. Reference to the bibliographic citations should not be made by numbers. Instead, using the above citations, where a reference is desired; either "Sniffen (1940)", "Sniffen, 1940: 186", or "Sniffen (1940) states that . . ."

Explanations of figures, Graphs, etc., should be typed on separate pages. All figures should be numbered consecutively beginning with the first text figure and continuing through the plates. If figures are to be inserted in the text this should be clearly indicated by writing "Figure —" at the appropriate place in the margin.

Illustrations, including lettering, should be arranged so that on reduction they will not exceed the dimensions of the maximum size of a printed page, 4½" x 6½", and so that they are well balanced on the page. The Journal will furnish the author with one plate (halftone or line reproduction) or its equivalent; additional figures, colored illustrations or lithographs may be used only if the author makes a grant covering the cost of production. Original drawings (which must be done in black drawing ink), not photographs of drawings, should accompany the manuscript. Photographs should not be used if a line and dot (stippled) drawing will suffice. If photographic prints are to be used they should be glossy, sharp and show good contrast. Drawings not neatly executed and labeled (do not use a typewriter), or which are submitted on yellow or yellowish-white paper will not be accepted.

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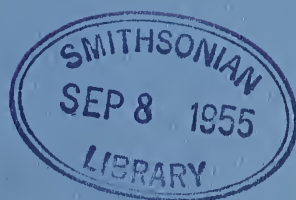
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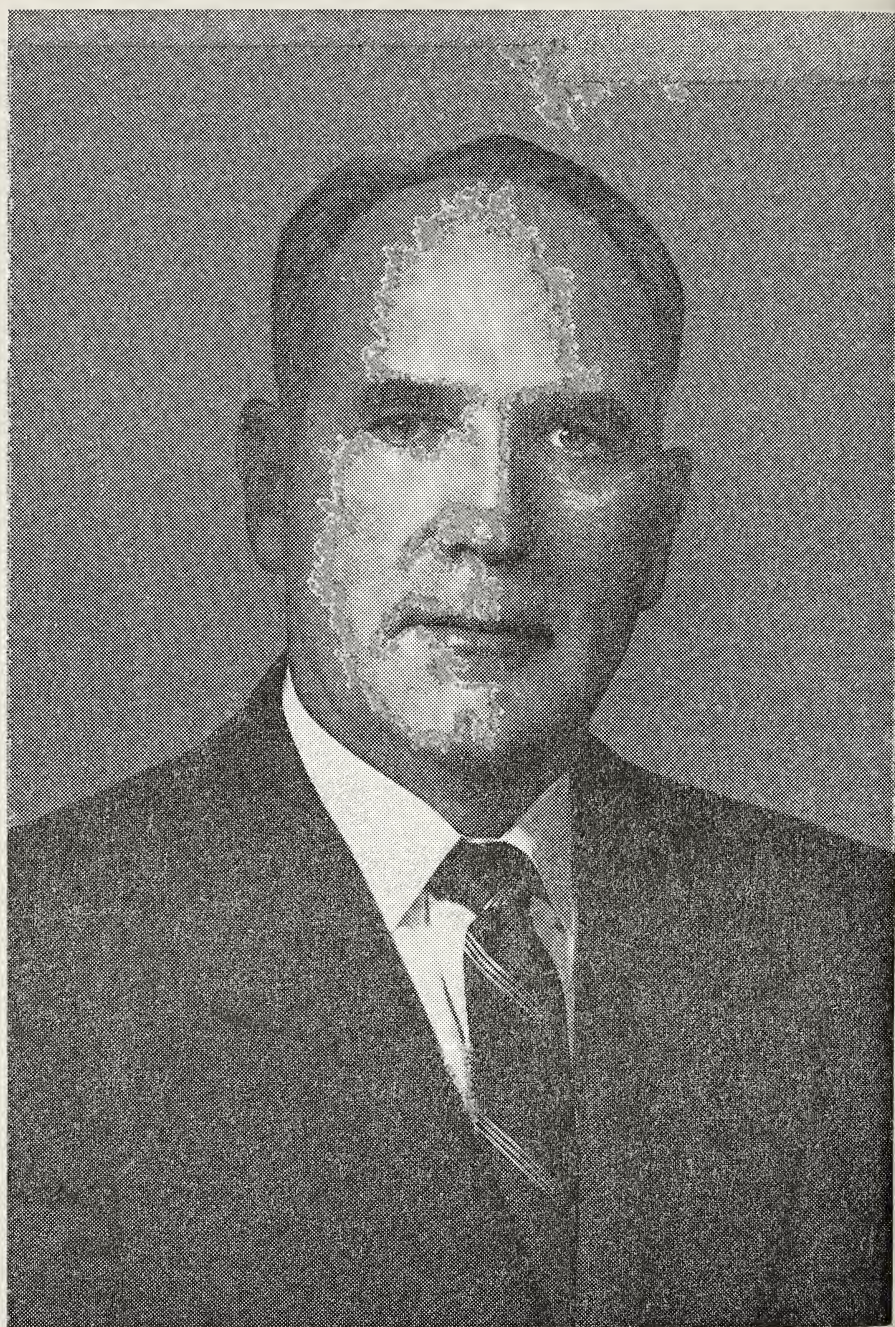
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# THE VIRGINIA JOURNAL OF SCIENCE

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## Boyd Harshbarger

### An Appreciation

In 1949 the Council of the Virginia Academy of Science decided to re-establish as the official organ of the Academy the Virginia Journal of Science. The first problem to be met was the appointment of an Editor-in-Chief. One man seemed to be preeminently qualified for this task, and so Dr. Boyd Harshbarger, then the President of the Academy was asked to serve. Dr. Harshbarger accepted without hesitation, and for the past five years has guided the affairs of the Journal. With the able assistance of Dr. Horton H. Hobbs, Jr. as Technical Editor, twenty numbers of the Journal were published during this time, and they stand as a tangible evidence of Dr. Harshbarger's service to the Academy. In addition, he has managed its business affairs so that the Journal has not only become self-supporting but has been able to set aside a reserve fund.

During this period Dr. Harshbarger's work as Chairman of the Department of Statistics of the Virginia Polytechnic Institute had been increasing and he found it necessary to submit his resignation as Editor-in-Chief, effective at the 1955 Annual Meeting. The Council has accepted this resignation with regret. The Virginia Academy of Science owes to Dr. Harshbarger a debt of gratitude for the unsparing manner in which he has devoted himself to his editorial duties. His efforts in behalf of this Journal have helped provide the impetus to carry it on and to continue its record as an organ for the publication of research by members of the Academy.

—IRVING G. FOSTER

AUG 31 1955



## On the Nature of Insect Resistance to Insecticides

J. M. GRAYSON AND D. G. COCHRAN

*Virginia Polytechnic Institute*

During the past forty-five years there have been many cases of insects exhibiting remarkable ability to adjust to the efforts of man to bring them under control by chemical poisons. Although Melander (1914) is generally considered to have first reported the occurrence of resistance in insects, it appears that this phenomenon was observed earlier by Smith (1897). During the period from 1914 to 1944 a number of insects showed definite evidence of being difficult to control with chemical insecticides that formerly were effective. In the last ten years there has been an increase in the number of reported cases of insect resistance to insecticides, so that the development of so-called resistant strains is currently one of the most serious problems in applied entomology. Many factors are probably involved but certainly it would seem that the more widespread use of contact, residual-type insecticides during the last decade is at least partially responsible.

An analysis of resistance in insects reveals a complex of independent and interacting factors which rather logically can be classified as physiological, behavioristic, and genetical. The purpose of this paper is to discuss briefly the subject of insect resistance to chemical insecticides from these standpoints, and to present certain apparent facts or ideas about resistance that perhaps are not generally understood. No attempt is made to review the complete literature on insect resistance; instead, selected references pertinent to the various discussions are employed. Babers (1949) and Babers and Pratt (1951) have published critical reviews of the literature up to 1951.

### DEFINITION OF TERMS

The term "resistance" is employed when an insect population consistently exhibits greater survival from exposure to a chemical insecticide than

<sup>1</sup>The junior author completed work for the Doctor of Philosophy degree from Rutgers University in October, 1954; now in military service.

*Editor's Note:* We are pleased to present this invited review article by Messrs. Grayson and Cochran.

\*Paper received March 1, 1955.

was originally the case. The term is used in the broad sense without regard to the mechanism involved in producing the resistance. The word "tolerance" is restricted to those cases where the chemical insecticide actually enters the body tissues of the insect but fails to kill the insect. Survival is usually dependent upon the ability of the insect to store the insecticide at some harmless location, to render it relatively non-toxic through biochemical action, or to develop a substitute for the physiological system affected. It would seem that the term "immunity" has no place in the various phenomena associated with insect resistance to insecticides. Certainly in the serological sense there is no immunity involved; at least the writers know of no evidence of insecticides exerting antigenic action resulting in the formation of antibodies.

#### PHYSIOLOGY OF RESISTANCE

*Resistance to Arsenicals.*—Hough (1934; 1943) has shown the difference between resistant and non-resistant strains of the codling moth to be one of general vigor, or "power of recovery" inherent in the individual. This difference can be demonstrated in the partially developed embryo, but it is most marked in the fully developed embryo or the newly hatched larva, and it disappears to a large extent in fully fed larvae. It is manifested by an increased ability to enter fruit sprayed with lead arsenate or non-arsenical insecticides, and also by increased efficiency of newly hatched larvae in attacking the fruit. On the other hand, Haseman and Burk (1929) and Haseman and Meffert (1933) found that codling moth larvae from resistant strains were no more successful than non-resistant larvae in surviving tests in which they were fed on drops of arsenious oxide solution placed in apple dents, or sodium arsenate or acid lead arsenate administered orally into the alimentary canal. These experiments would seem to disprove the existence of any real tolerance to arsenic in resistant strains of the codling moth; instead, resistance is apparently dependent upon the selection of a strain with sufficient vigor to survive adverse conditions until entry into the apple can be made without getting the poison.

While not directly pertinent to this argument, it is of interest at this point to mention the unsuccessful attempt by Campbell (1926) to induce a detectable tolerance to arsenic in individual silkworms. These tests were conducted by administering orally a number of sublethal doses of neutral sodium arsenate solution at intervals during larval development. Also in this connection, Schwartz (1923) has concluded that acquired tolerance to arsenic has not been convincingly demonstrated in man. The "arsenic

eaters" of Styria consumed enormous doses of solid arsenious oxide but they were in reality taking sublethal doses of soluble arsenic because most of the relatively insoluble arsenious oxide passes through the alimentary canal unchanged.

In the above two examples the gradual development of tolerance in the individual is involved. On the other hand, a different phenomenon would seem to be functioning in the development of most resistant strains of insects. Here the individual usually either survives or perishes from an initial exposure to the chemical poison, and only those individuals which survive contribute progeny to the next generation. Thus it is a case of population selection rather than the gradual acquisition of tolerance in the individual. This is not meant to imply that tolerance is absent in population selection; instead inherent resistance or tolerance is presumed to be the basis for selection.

*Resistance to HCN.* —It has been shown that both resistant and non-resistant strains of the California red scale and the black scale exhibit "protective stupefaction" to hydrogen cyanide (Gray and Kirkpatrick, 1929; Hardman and Craig, 1941; Lindgren, 1938). By this is meant that when first exposed to a sublethal concentration of HCN in air, followed by a lethal concentration, more scales are able to survive than when the reverse procedure is followed. There is some controversy as to the significance of this mechanism but, in general, it appears that protective stupefaction operates differently in the two strains with the resistant strain being able to utilize this mechanism in a manner to avoid being killed during the normal period of fumigation (Lindgren, 1938; Hardman and Craig, 1941). Regardless of its importance, however, protective stupefaction does not appear to constitute the entire escape mechanism because it has been reported that both resistant and non-resistant strains of scales are able to close the spiracles when exposed to HCN. This is of importance because with the non-resistant strain tested the spiracles remained closed only very briefly, whereas with the resistant strain they remained closed at least 30 minutes (Hardman and Craig, 1941). It is obvious that such a factor could be of importance, although Quayle (1942; 1943) does not believe it is, and has postulated an "inherent resistance within the organism." Likewise, Yust (1952) stated that tracheal closure does not cause resistance, nor does any other reaction which he was able to observe. Instead, Yust and Shelden (1952) have postulated that susceptibility to HCN is associated with a high degree of dependence on heavy metal-containing enzyme systems for tissue oxygen requirements, whereas resistance to HCN is associated with a high degree of dependence on metal-free, autoxidizable respiratory enzymes. This hypothesis is based on their finding that, among other things, oxygen consumption is depressed least in a super-resistant strain, intermediate in a resistant strain, and to the greatest extent in a non-resistant strain of scale insects after they were exposed to HCN. Although this evidence is very suggestive, it must be taken as indirect or circumstantial evi-



dence for the mechanism of resistance. It does not rule out the possibility of other factors being involved.

*Resistance to DDT.* —A review of the physiological studies on DDT has been published by Chadwick (1952). He discussed the various facts and theories on the mechanism for DDT intoxication in insects, and pointed out that much remains to be learned before the mode of action of this poison will be entirely clarified.

Some facts relative to the physiological nature of DDT resistance have been obtained. For example, significant correlations have been demonstrated between survival of treated insects and the conversion of DDT by these insects to its relatively non-toxic derivative, DDE (Perry and Hoskins, 1950, 1951; Sternburg and Kearns, 1950; Sternburg *et al.*, 1950; March and Lewallen, 1950). It has been shown that this detoxification, at least in houseflies, is produced by the action of an enzyme (Sternburg *et al.*, 1953; Sternburg *et al.*, 1954). This is probably not the entire mechanism of resistance to DDT, but there seems to be little doubt that DDT does readily enter the insect body (Lindquist *et al.*, 1951; Tahori and Hoskins, 1953). It also appears to be well established that in resistant strains of houseflies, DDT is prevented from exerting its lethal effect at least partially through a biochemical conversion. In such cases it would seem that true tolerance to the poison was demonstrated.

*Analysis of Information.* —From the above three examples of insect resistance to insecticides some interesting facts are evident. In all three cases the overall result is the same — *i. e.*, resistance to an insecticide. In each case, however, the means by which this resistance was achieved is different. With the codling moth resistance is apparently due to an increase in the general vigor of the resistant strain, there being no evidence of the development of tolerance to arsenic. In scale insects the question of the mechanism of resistance to HCN is still undecided. It seems almost certain, however, that HCN is entering the body of the insects but fails to kill the resistant ones. According to the definition employed herein, this represents true tolerance to HCN. If it should subsequently be proven that this resistance is attributable to a metal-free enzyme system, it will mean that resistance was achieved by the selection of a strain of insects capable of physiologically avoiding the effects of this poison. In the case of resistance to DDT true tolerance has been satisfactorily demonstrated, in that DDT is directly attacked by the resistant insects and converted to relatively non-toxic products. This apparently represents the first instance where detoxification has played a significant role in resistance.

### BEHAVIORISTIC RESISTANCE

Hough (1943) found that the newly hatched codling moth larvae from resistant strains showed less tendency to drop or wander from the fruit than similar larvae from non-resistant strains. He felt that this could be one of the factors contributing to the difference between a resistant and a

non-resistant strain, although it could be considered as a result rather than a cause of the essential difference between strains.

In a review of resistance in insects affecting public health, Hess (1953) calls attention to occurrences of resistance which might be attributed to changes in insect behavior. The resistance of *Musca domestica* to DDT in the Americas, and that of *M. vicini* in Africa and in Israel, is thought to be partially attributable to changes in insect behavior. The existence of behavioristic resistance to DDT in populations of *Anopheles* mosquitoes in the Americas and in Africa is suspected. In some cases it is manifested by a hyperirritability to DDT which causes the insect to become more restless and spend less time than normal upon treated surfaces. In insect populations containing both zoophilic and anthropophilic strains, it is thought that DDT treatments produce a higher kill of the latter with a resulting shift in the population towards the strain preferring animals other than man. This, of course, makes satisfactory control difficult because it leaves a reservoir of insects around those areas in which it is feasible to attempt control measures.

At the present time, one of the most intriguing features of this type of resistance is its mere existence. It is obvious from the preceding remarks that much remains to be learned about the details of this phenomenon. It should be particularly interesting to see how it is related to the other more thoroughly studied phases of resistance. In any case, it serves to re-emphasize the complexity of the whole problem.

### GENETICS OF RESISTANCE

*Resistance to Arsenicals and HCN.* —Hough (1928, 1934) made reciprocal crosses and back crosses between strains of the codling moth which differed in their ability to enter apples sprayed with lead arsenate. The results obtained have been interpreted by Brown (1951) as indicating autosomal, multiple-gene inheritance.

Dickson (1941) showed that resistance to HCN fumigation exhibited by the California red scale is inherited as a simple, sex-linked factor. This was later confirmed by Yust *et al.* (1943).

*Resistance to DDT.* —The information on the inheritance of resistance to DDT in the house fly is somewhat contradictory. Bruce and Decker (1950) made reciprocal crosses between resistant and non-resistant strains and from their results concluded that autosomal, multiple-gene inheritance is involved. On the other hand, results obtained by Harrison (1951) in the  $F_1$  and  $F_2$  progeny from reciprocal crosses indicated one factor, autosomal inheritance with the factor for susceptibility being incompletely dominant. A more critical study of these results by Harrison (1953) revealed that the character inherited as a simple Mendelian factor is in reality resistance to paralysis or "knockdown" rather than resistance to DDT-induced mortality. When Harrison studied the latter character she also found evidence of a complex inheritance in house flies. In addition, Jonhston *et al.* (1954) have

presented evidence for the involvement of a cytoplasmic factor in the inheritance of DDT resistance in the house fly. They concluded that this factor apparently constitutes the entire mechanism for resistance. It is extremely difficult to reconcile this and certain other rather sweeping conclusions made by these workers with the data which they presented.

The genetics of resistance in *Drosophila* is currently being investigated by a number of workers. Tsukamoto and Ogaki (1953) found some evidence of resistance to DDT in certain mutant strains of *Drosophila melanogaster* although they had never been exposed to DDT. They found no evidence of DDT resistance being linked with the sex chromosomes. Further work indicated one or a few major genes of DDT resistance to be located on the second chromosome near the gene for vestigial. It is not clear if they consider this to be the entire mechanism. Other workers have found DDT resistance in *Drosophila* to be inherited in a complex, multiple-factor manner (King, 1954; Crow, 1954; Pimental *et al.*, 1954).

Cochran *et al.* (1952) have shown that the inheritance mechanism for DDT resistance in the German cockroach is complex and that both chromosomal and extra-chromosomal factors seem to be involved. The genetics of resistance to chlordane in the German cockroach is currently being investigated<sup>2</sup>. The evidence indicates that resistance to chlordane in this insect may involve a slightly different genetic mechanism from that of resistance to DDT. The results obtained from  $F_1$  and  $F_2$  progeny of reciprocal crosses, back crosses, and progeny from paired matings within strains, have indicated that the factors for resistance to chlordane in the German cockroach are carried on the autosomes. This resistance probably involves the genes at several loci but there is no evidence of sex-linkage or extra-chromosomal factors.

*Analysis of Information.* —The existing knowledge of the genetics of resistance in insects is somewhat fragmentary but there is presumptive evidence of the following points: (1) a lack of dominance in resistance, as indicated by the intermediacy of progeny from reciprocal crosses of resistant and non-resistant strains, and (2) that, with the exception of the red scale, resistance is a multiple-factor character, as shown by its continuous distribution in the  $F_2$  and back crosses. A discontinuous distribution should result in segregation into definite Mendelian ratios.

It should be pointed out, however, that it is extremely difficult to ascertain the resistance of an individual insect; in fact it is usually the resistance of the population as a whole which is determined. Because of this, it is conceivable that a ratio resulting from two or three genetic factors might be masked by the techniques currently in use. It must be admitted that mortality is not an entirely satisfactory genetic criterion, particularly in view of the phenotypic variation which normally occurs within a population. There is also a possibility that the development of resistance is in

<sup>2</sup>Unpublished data obtained in the laboratory of the senior author.



reality a selection for heterozygotes because, superficially, the results obtained would be substantially the same as those which have been reported. A more plausible explanation, however, would seem to be that resistance is dependent on a number of independent non-allelomorphic genes probably not less than three, and that these genes are cumulative in their effect. In such cases the highest degree of resistance would result from homozygosity for resistance at each of the loci involved. This still permits that heterozygous individuals could exhibit considerable resistance. It is conceivable that a number of heterozygous loci might compare favorably with a smaller number of homozygous loci in producing resistance. Such a difference could explain why resistance is more rapidly lost in some strains than in others when selection is discontinued. In addition, it should also be mentioned that in the German cockroach and in the house fly there is evidence for the involvement of cytoplasmic factors in the inheritance of DDT resistance. It is not clear how these factors work in either case, but the authors suggest that they are transmitted through the female and act in a complementary manner with the chromosomal mechanism. These cytoplasmic factors also appear to be under the control of the nuclear genes because in both animals there are examples of loss of the apparent effect when genes for resistance and genes for susceptibility are both present. In any case, it appears that cytoplasmic inheritance in resistance does exist and should be taken into account in future experiments dealing with this subject.

### SOME OTHER CONSIDERATIONS

*Homozygosity in Resistance.* —When frequency of homozygotes is plotted against gene frequency in a random breeding population, a curve such as that shown in Figure 1 is obtained (data from Lush, 1945, p. 67). It is a theoretical presentation involving one gene pair, and ignores the possibility of mutations or other factors which might lower the frequency of the favored allele as homozygosity is approached.

If the degree of resistance to insecticides in insects is dependent to any appreciable extent upon a homozygous condition for genes favorable to resistance, as the authors believe, then the above mathematical concept should help to explain why resistance in an insect population develops slowly at first but more rapidly after the gene frequency has been increased through selection. Furthermore, it shows why complete homozygosity for resistance would be difficult to attain. This is true because of the diminishing number of individuals exposing the unfavorable allele to selection as the frequency of the favored allele approaches unity. For example, when the favored allele has reached a frequency of 0.9, individuals homozygous for this allele constitute 81 per cent ( $0.9^2$ ) of the population, those homozygous for the unfavored allele only 1 per cent ( $0.1^2$ ), and the remaining portion of the population is heterozygous. This principle can be extended to cases involving more than one locus. It is readily apparent

that the existence of a situation involving multiple factors would considerably complicate the process of selection for favored genes. Thus it is evident that homozygosity for resistance would be extremely difficult to attain in cases where genes at several loci are involved.

Frequency of  
Homozygotes (A)<sup>2</sup>

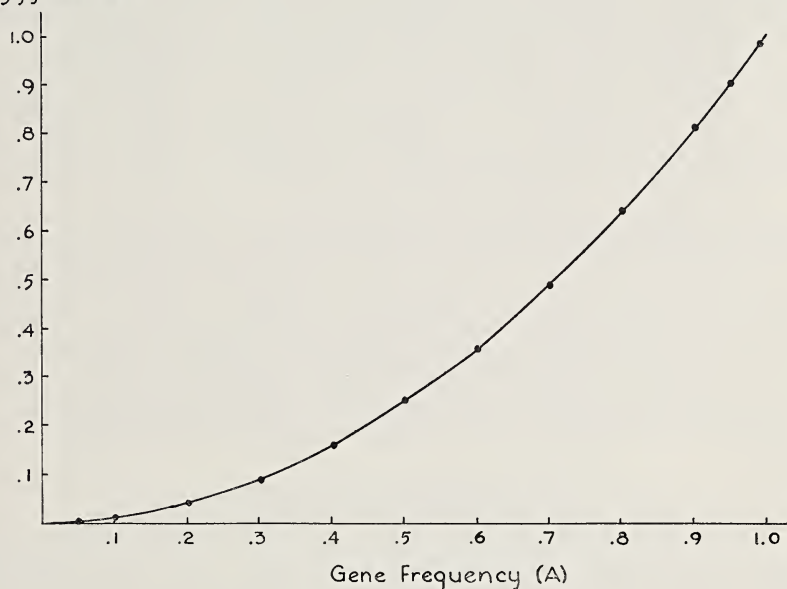


FIGURE 1. —Relation of gene frequency to frequency of homozygotes in a random breeding population.

*Rate of Inbreeding.* —It has been shown that some insecticidally selected insect strains are composed of individuals with lower biotic potential and smaller size than those in normal strains (Grayson, 1953, 1954). An occurrence of this kind might appear to be an expected result of inbreeding, but such an assumption is hardly feasible after analysis. The formula for determination of rate of inbreeding in an entirely closed population is as follows:

$$\left[ \frac{1}{8M} + \frac{1}{8L} \right] \times 100 = \text{percentage of inbreeding (Lush, 1945),}$$

where M is the number of males and L is the number of females in each generation that are effective in producing offspring.

From this it can be determined that the rate of inbreeding would equal 0.5 per cent each generation if 50 effective pairs were allowed to mate at

random, and it would be only 2.5 per cent if as few as ten pairs were involved. In view of the number of breeders that are likely to be used in the development of most selected strains, it would hardly seem logical to consider inbreeding as the principal factor responsible for lowered biotic potential and smaller size in selected strains.

*Types of Variation.* —Beard (1952a; 1952b) has recognized the following three sources of variation in response of an insect species to a toxic material: (1) variation in response by the individual insect, (2) variation in response by individuals about the group mean at a particular time, and (3) variation of the means of test groups. Also, he has pointed out that contributing to these phenomena is a dynamic versus a static type of variation, inherent in at least some species, which should be considered in evaluating the response of an insect to a chemical poison. Further work (Bliss and Beard, 1953) has shown that certain of these hypotheses are substantiated by experimental data.

The existence of these types of variation in insect response certainly seems plausible, although they might be expected to exert varying degrees of influence in different insect species. In those cases where little resistance results from exposure to a poison over a considerable period, it might be logical to assume that a high degree of variation is present and that the technique of selection has been reduced to minimum effectiveness. On the other hand, resistance has developed sufficiently rapidly in many insect species from the use of standard toxicological procedures that such methods would appear to be effective in avoiding the influence of variation.

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#### LITERATURE CITED

- BABERS, F. H. 1949 — Development of Insect Resistance to Insecticides. U. S. D. A. *Mimeo. Rept. No. E-776*.
- BABERS, F. H. AND J. J. PRATT. 1951 — Development of Insect Resistance to Insecticides — II. U. S. D. A. *Mimeo. Rept. No. E-818*.
- BEARD, R. L. 1952a — Insect Resistance to Insecticides. *Science*, 115 (2996):608.
- 1952b — Effect of Sublethal Doses of Toxicants on Susceptibility of Insects to Insecticides. *Jour. Econ. Ent.*, 45(4):561-567.
- BLISS, C. I. AND R. L. BEARD. 1953 — Static and Dynamic Variation in the Response of an Insect to Sublethal Doses of Two Gases. *Conn. Agri. Expt. Sta. Bull.*, 577, 24pp.
- BROWN, A. W. A. 1951 — Insect Control by Chemicals. *John Wiley and Sons, Inc. pp.* 759-763.



- BRUCE, W. N., AND G. C. DECKER. 1950 — House Fly Tolerance for Insecticides. *Soap and Sanit. Chem.*, 26(3):122-125;145-147.
- CAMPBELL, F. L. 1926 — On the Possibility of Development of Tolerance to Arsenic by Individual Insects. *Jour. Econ. Ent.*, 19(3):516-522.
- CHADWICK, L. E. 1952 — The Current Status of Physiological Studies on DDT Resistance. *Amer. Jour. Trop. Med. Hyg.*, 1 (3):404-411.
- COCHRAN, D. G., J. M. GRAYSON, AND M. LEVITAN. 1952 — Chromosomal and Cytoplasmic Factors in Transmission of DDT Resistance in the German Cockroach. *Jour. Econ. Ent.*, 45(6):997-1001.
- CROW, J. F. 1954 — Analysis of a DDT-Resistant Strain of *Drosophila*. *Jour. Econ. Ent.*, 47(3):393-398.
- DICKSON, R. C. 1941 — Inheritance of Resistance to HCN Fumigation in the California Red Scale. *Hilgardia*, 13:515-522.
- GRAY, G. P. AND A. F. KIRKPATRICK. 1929 — The Protective Stupefaction of Certain Scale Insects by Hydrocyanic Acid Vapor. *Jour. Econ. Ent.* 22(6):878-892.
- GRAYSON, J. M. 1953 — Effects on the German Cockroach of Twelve Generations of Selection for Survival to Treatment with DDT and Benzene Hexachloride. *Jour. Econ. Ent.*, 46(1):124-127.  
1954 — Differences between a Resistant and a Non-Resistant Strain of the German Cockroach. *Jour. Econ. Ent.*, 47(2):253-256.
- HARDMAN, N. F. AND R. CRAIG. 1941 — A Physiological Basis for the Differential Resistance of the Two Races of Red Scale to HCN. *Science*, 94(2434):187.
- HARRISON, C. M. 1951 — Inheritance of Resistance to DDT in the House Fly *Musca domestica* Linn. *Nature*, 167(4256):855-856.  
1953 — DDT-Resistance and Its Inheritance in the House Fly. *Jour. Econ. Ent.*, 46:528-530.
- HASEMAN, L. AND V. F. BURK. 1929 — A Determination of the Lethal Dosage of Arsenic for Missouri and Colorado Codling Moth Larvae. *Jour. Econ. Ent.*, 22(4)655-656.
- HASEMAN, L. AND R. L. MEFFERT. 1933 — Are We Developing Strains of Codling Moth Resistant to Arsenic? *Mo. Agri. Expt. Sta. Res. Bull.*, 202, 11 pp.
- HESS, A. D. 1953 — Current Status of Insecticide Resistance in Insects of Public Health Importance. *Amer. Jour. Trop. Med. Hyg.*, 2(2):311-317.
- HOUGH, W. S. 1928 — Relative Resistance to Arsenical Poisoning of Two Codling Moth Strains. *Jour. Econ. Ent.*, 21:325-329.  
1934 — Colorado and Virginia Strains of Codling Moth in Relation to Their Ability to Enter Sprayed and Unsprayed Apples. *Jour. Agri. Res.*, 48(6):522-553.

- 1943 — Development and Characteristics of Vigorous or Resistant Strains of Codling Moths. *Va. Agri. Expt. Sta. Bull.* 91, 32 pp.
- JOHNSTON, E. F., R. BOGART, AND A. W. LINDQUIST. 1954 — The Resistance to DDT by House Flies. Some Genetic and Environmental Factors. *Jour. Hered.*, 45(4):177-182.
- KING, J. C. 1954 — The Genetics of Resistance to DDT in *Drosophila melanogaster*. *Jour. Econ. Ent.*, 47(3):387-393.
- LINDGREN, D. L. 1938 — The Stupefaction of Red Scale, *Aonidiella aurantii*, by Hydrocyanic Acid. *Hilgardia*, 11(5):213-225.
- LINDQUIST, A. W., A. R. ROTH, W. W. YATES, R. A. HOFFMAN, AND J. S. BUTTS. 1951 — Use of Radioactive Tracers in Studies of Penetration and Metabolism of DDT in House Flies. *Jour. Econ. Ent.*, 44(2):167-172.
- LUSH, J. L. 1945 — Animal Breeding Plans. *Iowa State College Press*, 3rd Edition.
- MARCH, R. B. AND L. L. LEWALLEN. 1950 — A Comparison of DDT-Resistant and Non-Resistant House Flies. *Jour. Econ. Ent.*, 43(5):721-722.
- MELANDER, A. L. 1914 — Can Insects Become Resistant to Sprays? *Jour. Econ. Ent.*, 7(2):167-173.
- PERRY, A. S. AND W. M. HOSKINS. 1950 — The Detoxification of DDT by Resistant House Flies and Inhibition of This Process by Piperonyl Cyclonene. *Science*, 111:600-601.
- 1951 — Detoxification of DDT as a Factor in the Resistance of House Flies. *Jour. Econ. Ent.*, 44(6):850-857.
- PIMENTAL, D., H. H. SCHWARDT, AND J. E. DEWEY. 1954. — The Inheritance of DDT-Resistance in the House Fly. *Ann. Ent. Soc. Amer.*, 47(1):208-213.
- QUAYLE, H. J. 1942 — A Physiological Difference in the Two Races of Red Scale and Its Relation to Tolerance to HCN. *Jour. Econ. Ent.*, 35(6):813-816.
1943. — The Increase in Resistance in Insects to Insecticides. *Jour. Econ. Ent.*, 36(4):493-500.
- SCHWARTZ, E. W. 1923 — The So-Called Habituation to "Arsenic": Variation in the Toxicity of Arsenious Oxide. *Jour. Pharm. Expt. Ther.*, 20:181-203.
- SMITH, J. B. 1897 — The Influence of Environment on the Life History of Insects. *Gard. and Forest*, 10:344.
- STERNBURG, J. AND C. W. KEARNS. 1950 — Degradation of DDT by Resistant and Susceptible Strains of House Flies. *Ann. Ent. Soc. Amer.*, 43:444-458.
- STERNBURG, J., C. W. KEARNS AND W. N. BRUCE. 1950 — Absorption and Metabolism of DDT by Resistant and Susceptible House Flies. *Jour. Econ. Ent.*, 43(2):214-219.

- STERNBURG, J., E. B. VINSON, AND C. W. KEARNS. 1953. — Enzymatic Dehydrochlorination of DDT by Resistant Flies. *Jour. Econ. Ent.*, 46(3):513-515.
- STERNBURG, J., C. W. KEARNS, AND H. MOOREFIELD. 1954 — DDT-Dehydrochlorinase, an Enzyme Found in DDT-Resistant Flies. *Agri. & Food Chem.*, 2(22):1125-1130.
- TAHORI, A. S. AND W. M. HOSKINS. 1953 — The Absorption, Distribution and Metabolism of DDT in DDT-Resistant House Flies. *Jour. Econ. Ent.*, 46(25):302-306:829-837.
- TSUKAMOTO, M. AND M. OGAKI. 1953 — Inheritance of Resistance to DDT in *Drosophila melanogaster*. *Botyu-Kagaku*, 18:39-44.
- YUST, H. R. 1952 — Visible Reactions of California Red Scale in Relation to Resistance to Fumigation with HCN. *Jour. Econ. Ent.*, 45(6):-985-987.
- YUST, H. R., H. D. NELSON, AND R. L. BUSBEY. 1943 — The Influence of Repeated Fumigation with HCN on the Susceptibility of the California Red Scale. *Jour. Econ. Ent.*, 36(6):872-874.
- YUST, H. R. AND F. F. SHELDEN. 1952 — A Study of Physiology of Resistance to Hydrogen Cyanide in the California Red Scale. *Ann. Ent. Soc. Amer.*, 45(2):220-228.



## Monoecious Tendencies in the Crayfish, *Cambarus longulus longulus* Girard<sup>1</sup>

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When Hay (1905) recorded the presence of gonads of both sexes in one individual of *Orconectes limosus* (= *Cambarus affinis*), it was the first published account of crayfish hermaphroditism. Although he observed a well developed ovary with maturing oocytes, the rudimentary testis and vasa deferentia contained no spermatozoa and presumably the former lacked spermatids and spermatocytes. In two individuals of *O. propinquus propinquus* (= *Cambarus propinquus*), a further example of hermaphroditism was observed by Turner (1935) who noted scattered "patches of ovarian tissue" in an otherwise typical testis. It can be assumed that these specimens were capable of producing spermatozoa; however, in the absence of an histological description of these ovarian patches, the extent of their development remains obscure. Though male and female elements were associated in the gonads of the three specimens, no evidence was presented by either Hay or Turner illustrating the existence of both oocytes and spermatozoa in any one animal.

While working with *C. longulus longulus* in an attempt to ascertain what effect the removal of the eye stalk might have on the spermatogenetic cycle, another instance of a monoecious tendency was discovered in one of the control animals. In a sexually mature, form I male with no unusual secondary sexual characteristics collected at Piney River, Nelson Co., Virginia on Nov. 11, 1954, thirteen oocytes were observed in the three lobes of the testis. With the possible exception of the proximal acini in each lobe, where the greater number of oocytes occurred, their distribution was apparently at random. Since young oogonia are difficult to distinguish from spermatogonia or primary spermatocytes, and further, since the proximal portions of the testicular lobes mature first, it is probable that there were additional potential oocytes in the distal portions of the lobes.

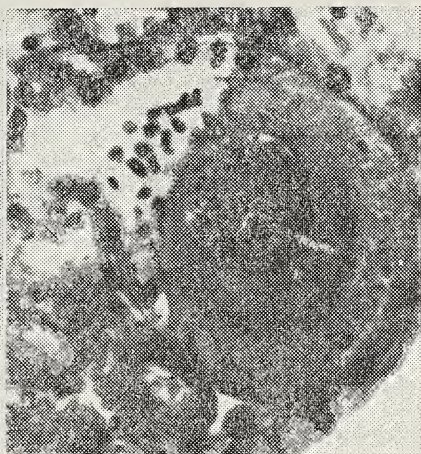
The oocytes vary from 26-109 $\mu$ . in diameter with a corresponding range in nuclear diameter from 21-60 $\mu$ . The arithmetic means of the diameters of thirteen oocytes and nuclei are 42 $\mu$ . and 28 $\mu$ ., respectively. These are distinguished readily from the primary spermatocytes by their larger size and by the sizes of their nuclei — the diameter of the primary spermatocytes average 20 $\mu$ . and that of the nuclei, 14 $\mu$ . In most cases the developing oocytes are small enough so that other cells occur within the acinus. Those oocytes, however, with a diameter of 100 $\mu$ . or more tend to fill the entire

<sup>1</sup>The author acknowledges the guidance afforded by Dr. Horton H. Hobbs, Jr., of the University of Virginia, in the preparation of this paper.

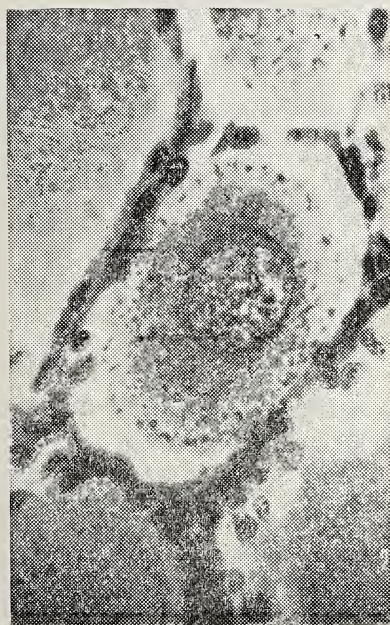
\*Paper received June 12, 1955.



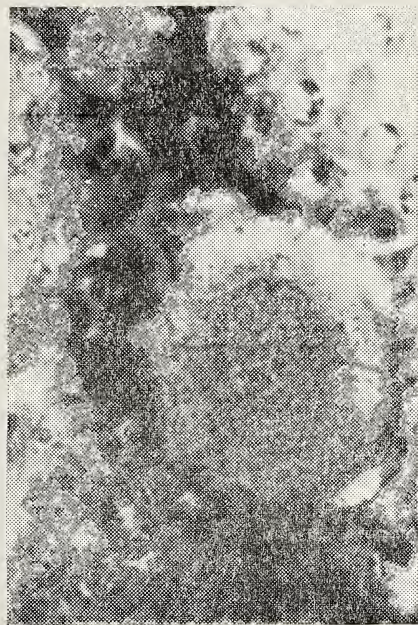
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2



3



4



acinar space. Figure 1 illustrates such an oocyte  $109\mu$ . in diameter almost filling the acinus and apparently pushing the spermatozoa into a tubule as it increases in size. A clearer illustration of the close association between the oocyte and the spermatozoa is afforded by Figure 2.

Soon after their initiation, oogonia in the testis are similar to the spermatogonia in their circular outline, but with development, they assume a more oval shape. This compares with the maturation of oogonia in the ovary of *C. longulus longulus*. The ovarian oocyte in Figure 3 measures  $149\mu$ . in length and in all morphological respects, it resembles the oocyte in the testis.

On Dec. 27, 1954, the testis of another form I male from the same population was found to contain twenty-one oocytes. Mature spermatozoa were abundant in the vas deferens. Oocytes again occurred in all three lobes of the testis, occasionally two or three occupying a single acinus. The cells range from  $32$ - $117\mu$ . in diameter, with an arithmetic mean of  $50\mu$ ., and all appear morphologically similar to the oocytes in the ovary as well as to those in the previously mentioned testis. Figure 4 shows an oocyte completely filling an acinus surrounded by other acini that contain spermatogonia or primary spermatocytes; in addition, darkly stained nuclei of the epithelial cells and connective tissues associated with the acini and tubules may be observed.

Approximately 120 specimens from the Piney River population have been examined histologically and of these, only two were found with this anomaly. There is insufficient evidence at this time to hazard an estimate on the percentage of crayfish with an "ovo-testis" at this locality. In the testes of more than 100 additional specimens of the same species from the Charlottesville area no monoecious tendencies were observed.

There is one point of interest concerning the position of the germinal epithelium in the testis. Finding oocytes proliferating from cells of the acinar walls would indicate that it is the epithelial lining of the acinus, and hence the tubule (Word 1954), which has the additional potential of giving rise to gametes.

#### LITERATURE CITED

- HAY, WILLIAM PERRY 1905. — Instances of Hermaphroditism in Crayfish *Smithsonian Misc. Coll.*, 48(2):222-228.
- TURNER, C. L. 1935. — Studies on the Secondary Sexual Characters of Crayfishes X. The Annulus Ventralis in True Intersexes of *Cambarus* *Biol. Bull.*, 69(2):269-273.
- WORD, B. H. 1954. — Observations on the Testis of the Crayfish, *Cambarus montanus acuminatus* Faxon, *Unpublished Master's Thesis, University of Virginia*.



## The Nesting and Ovarian Eggs of the Dusky Salamander, *Desmognathus f. fuscus* Raf., in Southeastern Virginia

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*University of Virginia, College of William and Mary, and  
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The literature contains no information on the time and duration of nesting of *Desmognathus f. fuscus* Raf. in southeastern Virginia, or on the ecology and natural history of this nesting. Similarly, there has been no previous study of behavior of the female attending the nest, of the relationship between the number of large ova (ready for deposition) in the ovaries of a gravid female and her size, and of the changes in large ova dimensions through the year. Reported here is the first description of a nest of the dusky salamander in southeastern Virginia with ecological and natural history observations; a study of the relationships between the snout-vent lengths of 34 gravid females and their large ova complements; a comparison of left ovary contents with those of right ovaries to detect any unilateral tendencies; and a study of the conditions of the ova in 115 females gathered throughout the year.

On August 23, 1953 a single compact nest of *Desmognathus f. fuscus* eggs was found beneath a small log lying on a moist mud flat about five yards from the nearest surface water. The female darted into a tunnel in the log as soon as the nest was uncovered. This behavior is at variance with reports in the literature that nests are attended by females that were found curled around the egg masses and made no effort to escape (Robertson and Tyson, 1950). The female guarding the eggs is "undoubtedly the mother" according to Wilder (1913), but as far as the authors can determine it has never been verified by marking females and their large ova that they actually do attend the eggs they deposit. The female that attempted to escape when the nest was exposed was found to have a recently ingested (little digested) annelid worm in her stomach, and the egg group she had been attending contained embryos having total lengths of 10 mm., evidence that they were between three and four weeks old. Obviously the female had devoted part of her time of "attending" the nest to feeding herself. This behavior is sharply contrasted with that of *Hemidactylium scutatum* females, found attending their eggs, in which no stomachs contained recognizable food items. (Wood, 1951).

The egg group consisted of 34 embryos. In Massachusetts nests of *Desmognathus f. fuscus* contain from 14 to 28 eggs, averaging 20 (Wilder, 1907); in New York, from 12 to 26 eggs, averaging 17 (Bishop, 1941); in Pennsylvania, from 22 to 34 eggs were found in 44 nests (Pawling, 1939) and in Ohio, 17 to 36 eggs, averaging 26.3 (Wood and Fitzmaurice, 1948). Nests contain fewer eggs south of Virginia—in the range of *D. f. brimleyorum* Stejneger and intergrades between this subspecies and the northern one. In Georgia a nest contained six eggs (Neill and Rose, 1949); in North Carolina six nests contained from 14 to 20 eggs (Robertson and Tyson, 1950), and two nests contained 17 and 22 eggs respectively (Eaton, 1953). The Virginia nest contained an egg complement near the maximum reported in the literature.

The nest, found near a drainage ditch near Suffolk, Nansemond County, was a moist hollow beneath a small log imbedded in mud, and the cavity containing the eggs might well have been formed by the turning movements of the female prior to egg deposition; females are known to "excavate" nests in this way (Wilder, 1913). Usually nests are immediately adjacent to water areas, and never more than two or three feet from water

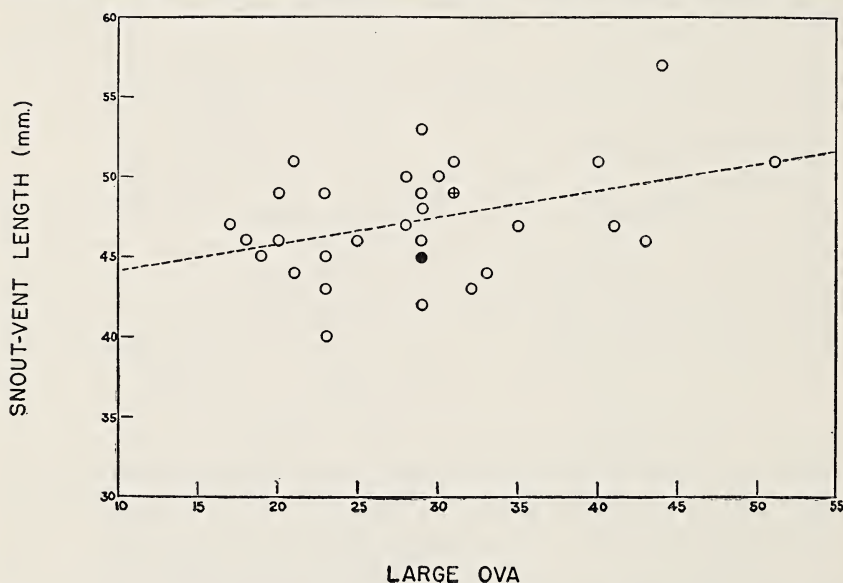


FIGURE 1. The relationship between the large ova complements of 34 *Desmognathus f. fuscus* from Southeastern Virginia, and the snout-vent lengths of the females. The open circles indicate one specimen; dot, two specimens; crossed circle, three specimens.<sup>1</sup>

1. The lines in Figures 1 and 2 were fitted to these data by eye.

(Wilder, 1913). This nest was in a crevice which extended down into the mud from beneath the log, and would have been submerged if surface water were on the mud flat. Since females of this species do not lay eggs beneath water, it is evident that the nest was originally placed 15 feet from water just as it was when discovered later. Placing their eggs out of water, yet adjacent to it, is evident of less primitive nesting habits according to Noble (1931); the terrestrial location of this nest indicates that another step in the evolution of this species is in progress.

Wilder (1913) considers that the number of large ova in a gravid female approximate the number of eggs found in a nest. Dunn (1926) suggests the ova complement is related to the size of the female, and Bishop (1941) noted that although a large complement of ovarian eggs may equal in number the eggs in a nest, it usually exceeds it. Thirty-four gravid dusky salamanders were collected under logs and slabs beside brooks in James City and York counties in February and April, 1949 and 1950 — ap-

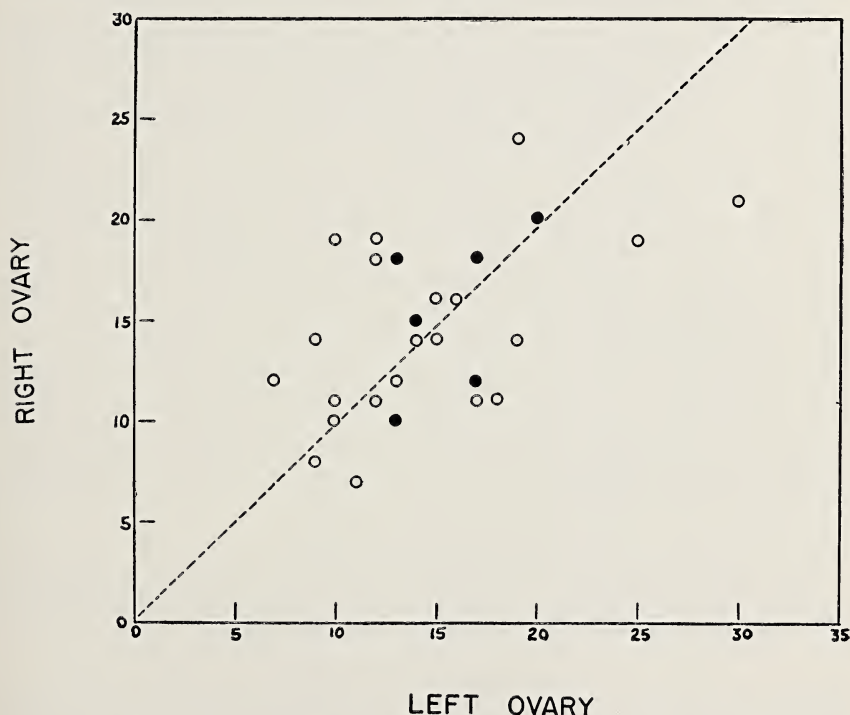


FIGURE 2. The relationship between the numbers of large ova in the right and left ovaries of 34 *Desmognathus f. fuscus*. The open circles indicate one specimen; dots, two specimens. <sup>1</sup>



proximately five and three months prior to the egg laying season in this area, respectively. The oviducts of all of the specimens were unmarked by the distension and convolutions which indicate that egg deposition has been partially completed. Snout-vent measurements of these females ranged from 40.0 to 57.0 mm., averaging  $47.4 \pm 3.4$  mm. Large ova ranged in number from 17 to 51, averaging  $29 \pm 8$ . Figure 1 shows the relationship between size of females and their complements of large ovarian eggs. For females of a specific size (e.g., snout-vent length 46 mm.) the number of ovarian eggs may vary widely (e. g., 18 to 43 large ova in this case). Wilder (1913) reported 10 or 11 large ova in each ovary as a consistent finding in her dissection of gravid *fuscus*. No such consistent complement regardless of the size of the female has been noted.

In elongated animals such as salamanders there is frequent longitudinal modification of organs, and in some cases one of a pair of organs becomes vestigial. Comparison of the ovary contents, Figure 2, shows that this is not true of the ovaries in *fuscus*.

The time and duration of nesting in dusky salamanders is poorly understood. Some reports of nests in the literature are based upon observations made at time of larval emergence, and others shortly after egg deposition. For this reason it has been believed that the egg-laying season is an extended one. Examination of the ovaries of 115 females gathered during the year indicates the egg-deposition season is a brief one. Large ova in females collected from October to February contained deutoplasm which was distinctly yellowish, in contrast to the whitish translucent contents of the many small ova; their dimensions ranged in 9 specimens from 1.0 to 1.5 mm., and no evidence of growth during this winter period was evident. Ova were larger in specimens collected in February, March, and April, and in 49 specimens it was noted they increased in size to a maximum of 2.5 mm. Twelve specimens collected in June and July contained large ova which reached a maximum diameter of 3.0 mm.; none had started spawning. All 39 females examined in August had completely spawned the large ova complements. No large ova were detected in specimens collected and examined in September, and not until October was yellow deutoplasm observed. From this it appears that nesting occurs in late July or early August in southeastern Virginia.

#### ACKNOWLEDGMENT

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#### LITERATURE CITED

- BISHOP, S. C. 1941. The Salamanders of New York. *N. Y. State Mus. Bull.*, (324):1-365.
- DUNN, E. R. 1926. The Salamanders of the Family *Plethodontidae*. *Smith College Anniv. Ser.*, Northampton, Mass. pp. 1-441.

- EATON, T. H. 1953. Salamanders of Pitt County, North Carolina. *Jour. Elisha Mitchell Sci. Soc.*, 69:49-53.
- NEILL, W. T. AND F. L. ROSE 1949. Nest and Eggs of the Southern Dusky Salamander, *Desmognathus fuscus auriculatus*. *Copeia*, (3):234.
- NOBLE, G. K., 1931. The Biology of the Amphibia. *McGraw-Hill Book Co.*, N. Y., pp. 1-577.
- PAWLING, R. O. 1939. The Amphibians and Reptiles of Union Conuty, Pennsylvania. *Herpetologica*, 1:165-169.
- ROBERTSON, W. B. AND E. L. TYSON 1950. Herpetological Notes from Eastern North Carolina. *Jour. Elisha Mitchell Sci. Soc.*, 66:130-147.
- WILDER, I. W. 1907. On the Breeding Habits of *Desmognathus fusca*. *Biol. Bull.*, 32:13-20.
1913. The Life History of *Desmognathus fusca*. *Biol. Bull.*, 24:-251-342.
- WOOD, J. T. 1951. An Ecological and Biometric Investigation of the Nesting of the Four-Toed Salamander, *Hemidactylium scutatum* (Schlegel), in Virginia. *Col. of William and Mary*. pp. 1-47. (Unpublished thesis).
- WOOD, J. T. AND M. E. FITZMAURICE 1948. Eggs, Larvae, and Attending Females of *Desmognathus f. fuscus* in Southwestern Ohio and Southeastern Indiana. *Amer. Midl Nat.*, 39:93-95.

## The Land Snails of Hanover, Henrico, and Chesterfield Counties, Virginia<sup>1</sup>

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*University of Richmond*

A preliminary list of the Mollusca of Hanover County was published by J. B. Burch (1952) in which twenty-five species and sub-species of land snails were reported. P. R. Burch (1950) listed six species of land snails for Henrico and Chesterfield counties, and J. B. Burch (1954) reported twenty-four species and sub-species for Henrico County. *Triodopsis obsoleta* (= *Triodopsis hopetonensis obsoleta*) (Pilsbry) was reported by Hu-bricht (1953) as being an introduced form in Richmond.

This paper is the result of a two-year investigation of the distribution and relative abundance of land snails in this area of Virginia.

### DESCRIPTION OF THE AREA

Hanover, Henrico, and Chesterfield counties cover an area of 1179 square miles in east-central Virginia. The area is limited on the north by the North Anna and Pamunkey Rivers and on the south by the Appomattox River. The eastern boundary is for the most part marked by the Pamunkey, James, and Appomattox Rivers, and Matadequin and Turkey Island Creeks. The western boundary is in part formed by Tuckahoe and Skin-quarter Creeks.

Two physiographic regions, the Coastal Plain to the east and the Piedmont Plateau to the west, merge along a line which crosses each county, dividing Hanover and Henrico counties roughly into equal halves and Chesterfield County into an area about four-fifths of which lies in the Piedmont Plateau. This fall zone is several miles wide, with no definite boundaries.

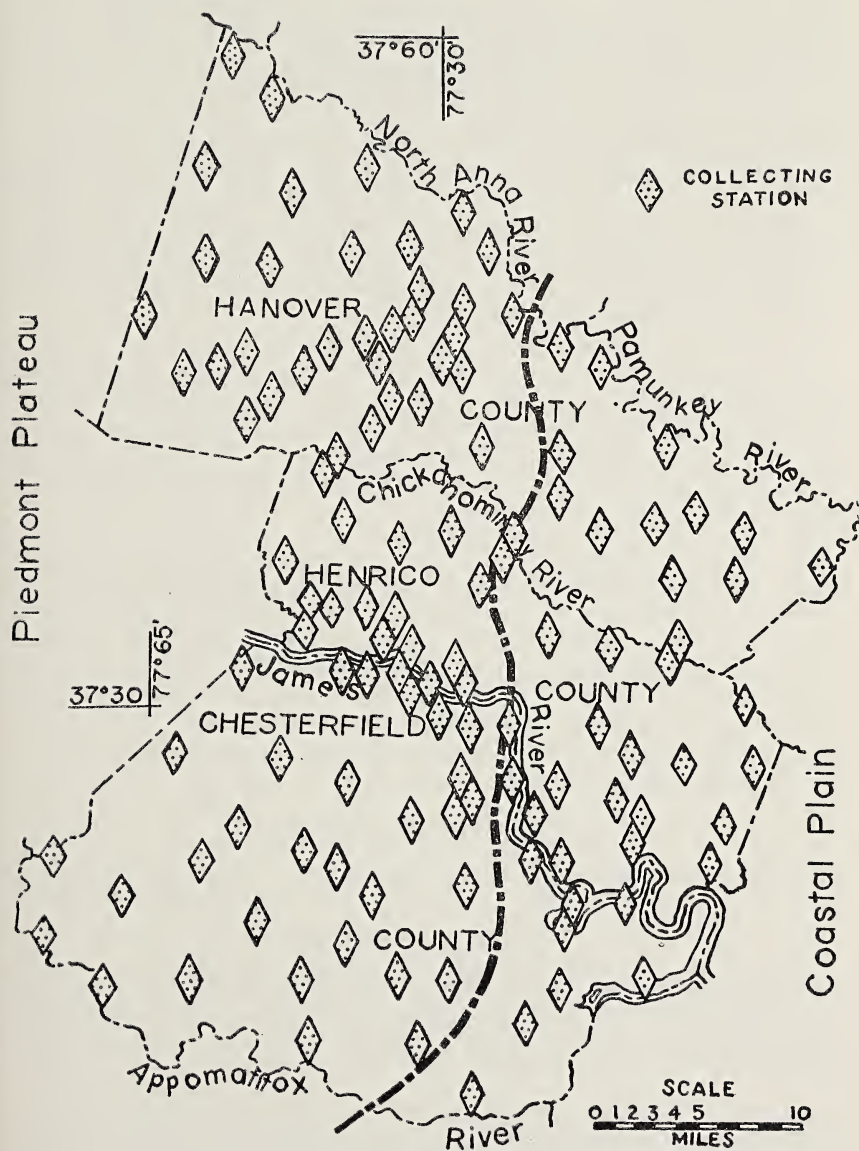
The Piedmont province is a region of hard rocks and rolling topography. The soils have been derived mainly from granite and gneiss formations and comprise primarily the Durham and Cecil series (Bloomer, 1938). The Cecil series is the most widespread type of soil occurring over the Piedmont region. It is a gray, red, or brown loam with a red clay subsoil. What was formerly a plateau is now so deeply eroded by drainageways that little of the plateau surface remains. In its eastern part the Piedmont Plateau has an average elevation of about two hundred feet above sea level, but it rises gradually toward the west. Most of the streams which cross it flow

<sup>1</sup>This represents a portion of a M. S. thesis submitted to the Department of Biology, University of Richmond, June, 1954.

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\* Paper received December 6, 1954





through narrow valleys in rocky channels.

The Coastal Plain is a region of sand, clay, and other soft materials, laid down on an eastward-sloping floor of granite and other crystalline rocks and dips gradually to the east. The soils differ from those of the Piedmont in their loose structure, lack of loaminess, the predominance of sand, and the frequent occurrence of water worn gravel throughout the soil profile. For the most part the Coastal Plain consists of a wide plateau trenched by broad, terraced valleys of numerous streams. The larger streams are tidal estuaries as far inland as the zone in which the hard rocks rise from under the deposits of the Coastal Plain and become high enough to cause rapids. As the rise of these rocks is usually fairly steep the stream valleys narrow in a short distance into rocky gorges which mark the change from the Coastal Plain to the Piedmont province.

The major portion of the two regions is well drained by several rivers and their tributaries. The most extensive drainage system is the James River which flows through the central part of the area, marking the boundary between Henrico and Chesterfield counties. The largest tributary of the James in this area is the Appomattox River. The drainage system to the north consists primarily of the North Anna, Little, New Found, Pamunkey, Chickahominy, and South Anna Rivers.

The climate is generally mild with an average annual temperature of 12° C. Because of a difference in elevation of almost three hundred feet, the average temperature of the region near the western boundary is slightly cooler than that of the district near the eastern boundary; however, there is no apparent difference in the precipitation. The annual precipitation averages about 43 inches (Latimer and Beck, 1913), and the wet months occur during the growing season in the spring and summer. The first killing frost comes usually about the first of November and the last severe frost is usually during the early part of April.

### DISTRIBUTION OF SPECIES

Although no species in this area is *abundant*, i.e., "observed in numbers every time search is made for it in the proper habitat" (Dice, 1952), according to the scale of abundance commonly employed by ecologists, several species are common and generally distributed throughout the area. Several species have been found at only one station and may be introduced forms or epibiotics. Others are of frequent abundance and generally distributed and some are apparently restricted to a particular physiographic province.

*Common* species are arbitrarily defined as those found in sixty-five per cent or more of the total number of samples; *numerous* or *frequent* species in twenty-five to sixty-five per cent of the samples; *occasional* or *scarce* species in five to twenty-five per cent of the samples; and *rare* species in less than five per cent of the collections. Two species are common, five

frequent, fifteen occasional, and twelve rare.

In the section to follow is an annotated list of species with notes on distribution and abundance.

ORDER STYLOMMATOPHORA

SUBORDER SIGMURETHRA

FAMILY ENDODONTIDAE

*Anguispira alternata* (Say) is found occasionally in scattered localities in Hanover and Henrico counties in hardwood forests. It sometimes occurs in lots with *Anguispira fergusonii*.

*Anguispira fergusonii* (Bland) is of occasional occurrence and is generally distributed over the three counties. It has been found in greatest numbers in thickly forested river valleys and has been found associated with various oak and elm communities, being most abundant in oak-elm associations. It seems to be restricted to soils very high in calcium content and is most abundant at a pH range of 6.3 - 6.7.

*Helicodiscus parallelus* (Say), a small, flattened, greenish-yellow snail, is common throughout the area and, although associated with all the types of plant communities where collections were made, is prevalent in oak-pine stands. It is exceeded in abundance only by *Zonitoides arboreus* (Say).

*Punctum minutissimum* (Lea), a minute snail, is rare and has been found in this area only in the Piedmont province, although P. R. Burch (1950) has reported it from the Coastal Plain in Norfolk County. It has been found associated with oak-elm and oak-pine communities, and only in the pH range of 6.3 - 6.7.

*Discus patulus* Deshayes was reported by P. R. Burch (1950) from Henrico County but was not found during this investigation.

FAMILY HAPLOTREMATIDAE

*Haplotrema concavum* (Say), generally considered a carnivorous species, is of frequent occurrence, and has been found in a large number of plant communities, although it is more commonly associated with oaks, maples, and willows. Ingram (1941) considers this species an omnivore rather than a carnivore and in this case the plant association may have some direct influence on distribution.

FAMILY POLYGYRIDAE

*Mesodon appressus sculptor* Chadwick is of rare occurrence and was found only along the James River lowlands, primarily on the Chesterfield County side of the river. It was encountered most frequently in willow and sycamore-willow communities and was associated only with soils very high in calcium content.

*Mesodon thyroideus* (Say), one of the larger land snails, is numerous in this area, being found most abundantly in the Piedmont, although P. R. Burch (1950) reported its occurrence in Elizabeth City and James City counties. Rehder (1949) found it "common" at Virginia Beach, Princess



Anne County. It is generally associated with woodlands having a predominance of oaks.

*Stenotrema hirsutum* (Say) is another species which seems generally to be restricted to the Piedmont, but has been found by P. R. Burch (1950) in Elizabeth City County. It has an occasional occurrence in the Piedmont and has been found in two localities in the fall zone. Those individuals found in Henrico and Chesterfield counties comprise a small race, averaging somewhat less than 7 mm. in diameter. *S. hirsutum* has been found in a number of oak and elm associations, most frequently in oak-pine associations. Although Lee (1952) states that in the vicinity of Ann Arbor, Michigan, *S. hirsutum* is restricted to river valleys and alkaline soils (pH range 7.5 - 8.5) this is not the case here. Its occurrence is most frequent in woodlands some distance from streams, and it has been found only in soils having a pH range of 6.2 - 7.4.

*Triodopsis albolabris* (Say), the largest land snail found in this area, is somewhat solitary, of occasional occurrence, and has been found only in associations in which oak is one of the dominant trees - most frequently in oak-maple communities.

*Triodopsis fallax* (Say) is a scarce species, and except for one station near the fall zone in the Coastal Plain was found only in the Piedmont province.

P. R. Burch (1950), however, has found it in James City County, and Hubricht (1953) has reported it from York, New Kent, Sussex, Southampton, and Franklin counties. It has been found most generally in edification communities.

*Triodopsis hopetonensis* (Shuttleworth) has been found in only one locality in Henrico County, near the James River, Va. Rt. 605, and in two localities in Chesterfield County, near the intersection of Va. Rt. 655 and Va. Rt. 659, and near the James River, Va. Rt. 746. Hubricht (1953) states that it apparently does not occur north of the James River in Virginia. Its occurrence in Henrico may be due to accidental transportation.

*Triodopsis obsoleta* (= *Triodopsis hopetonensis obsoleta*) (Pilsbry) has been reported by Hubricht (1953) as an introduced form in Richmond, but specimens have not been found in this study. P. R. Burch (personal communication), however, believes that polygyrid forms with aperture dentation reduced or lacking are probably the result of insufficient calcium in the diet, since laboratory culture of snails in cultures deficient in food and calcium show reduced aperture dentation. Hubricht's *T. obsoleta* may have been atypical *T. hopetonensis*.<sup>3</sup> *T. hopetonensis* has been found in oak, sycamore-willow, and willow associations.

*Triodopsis tridentata juxtidens* (Pilsbry) is generally distributed and of frequent occurrence throughout the three counties. It has been found pre-

<sup>3</sup>According to the large sample Mr. Hubricht gave the U. S. National Museum, Dr. J. P. E. Morrison (personal communication) thinks his "*obsoleta*" reported for Richmond is actually *Triodopsis messana*.

dominantly in oak and elm communities, and at a pH range of 5.8 - 6.2, decreasing in number as the pH increases.

#### FAMILY ZONITIDAE

*Euconulus dentatus* Sterki. — Dr. Morrison identified specimens sent to the U. S. National Museum from Falling Creek, Va. Rt. 653, Chesterfield County as *E. dentatus* and doubts if *Euconulus chersinus* (Say), a southern species, and *Euconulus fulvus* (Muller), a northern species, occur in this area of Virginia. *E. chersinus* and *E. fulvus* were previously reported from Hanover County in 1952, and *E. chersinus* from Henrico County in 1954. These previous identifications were made from descriptions given by Pilsbry (1946) and based partly on the absence of dentations in the last whorl.

*Hawaiiia minuscula* (Binney), a species of occasional occurrence, is generally distributed throughout the area, and has been found most abundant in oak-sycamore communities and at a pH range of 6.3 - 6.7.

*Retinella burringtoni* (Pilsbry) was found frequently in the Piedmont region, and usually in plant associations dominated by oaks. It has rarely been observed in the Coastal Plain. The southernmost point in its range, as published, is at its type locality, Natural Bridge, Rockbridge County, Virginia (Pilsbry, 1946).

*Retinella indentata* (Say) is of frequent abundance and generally distributed over the entire area in association with a variety of trees. Its most common occurrence is in oak-poplar stands. *R. i. paucilirata* (Morelet) was reported in 1952 from Hanover County, but all specimens were probably atypical *R. indentata*. *R. i. paucilirata* differs from the typical *R. indentata* mainly in a slightly larger umbilicus and somewhat greater size. Although some specimens from this area fit the description of *R. i. paucilirata* very well, J.P.E. Morrison identified all specimens sent from Hanover and Henrico counties as *R. indentata*. The form *R. i. paucilirata* is a southern variety, Rehder (1949) giving its northernmost record in the Coastal Plain as along State Route 170, south of Moyock, Currituck County, North Carolina. Rehder (1949) giving its northernmost record in the Coastal Plain as James River, U. S. 1, and near the intersection of Va. Rts. 667 and 690), both in the Piedmont of Chesterfield County and in different plant associations, viz., sycamore-willow and oak-pine respectively. It has not been reported from any of the surrounding counties.

*Ventridens ligera* (Say), a large snail of occasional occurrence, is most common in the eastern James River flood plain. It was observed most frequently in association with oak-sycamore stands in the lowlands and in oak-pine stands in the higher regions. Although Rehder (1949) states that it is apparently rare in the coastal region, but common at Virginia Beach, Princess Anne County, Hubricht (1953) has reported it from Southhampton, Nansemond, and Elizabeth City counties.

*Ventridens suppressus magnidens* (Pilsbry) was found occasionally throughout the area except for the Coastal Plain of Chesterfield County.

Most frequently it was collected in oak and oak-pine associations and at a pH range of 5.3 - 5.7. There seems to be a local race in Hanover County different from the forms found in the two counties to the south. This local race comprises individuals in which the teeth diminish or even disappear in the fully adult stage (as they do in *V. suppressus* (typical form) (H. A. Pilsbry, personal communication). *V. gularis theloides* (Pilsbry) was reported in 1952 from Hanover County but all specimens were later identified by Pilsbry as this local race of atypical *V. suppressus*.<sup>4</sup>

*Zonitoides arboreus* (Say) is the most common and widely distributed land snail found in this vicinity. It is not restricted to woodlands but when found in plant communities is most frequently associated with oaks. It is found in the most acid and the most alkaline soils, *i.e.*, in the pH range 4.8-7.7, but most frequently in a range of pH 6.8-7.2.

#### SUBORDER HETERURETHRA

##### FAMILY SUCCINEIDAE

*Succinea aurea* Lea was found at five localities in the eastern part of the area along the James River. Specimens were picked from rocks near the waters edge.

#### SUBORDER ORTHURETHRA

##### FAMILY CIONELLIDAE

*Cionella morseana* (Doherty) was found at only one locality, near the James River, Va. Rt. 679, Chesterfield County. It was found under decaying oak, poplar, and sycamore leaves at the base of a granite cliff on soil with a pH of 6.0 and a very high calcium content.

##### FAMILY PUPILLIDAE

*Columella edentula* (Draparnaud), a scarce, solitary species, was found in both physiographic provinces in all three counties. P. R. Burch (personal communication) also found it in King William County. It has been found associated with oak-pine and maple-sweet gum stands.

*Gastrocopta armifera* (Say) was found at only one station, Va. Rt. 657, three miles west of Ashland, Hanover County, under and around a compost pile. It has been reported by P. R. Burch (1950) from Dinwiddie County.

*Gastrocopta contracta* (Say), although a scarce species, is distributed over the entire area. It is most abundant in oak and oak-poplar associations on soils with a pH range of 6.8 - 7.2. Found rarely in soils with less than very high calcium content.

*Gastrocopta pentodon* (Say) is rare and apparently restricted to the Piedmont region, although it is reported in the Coastal Plain from Elizabeth City County (P. R. Burch 1950). It has been found only in plant associations abundant in oak.

*Gastrocopta procera* (Gould) is rare in this area, and has been found

<sup>4</sup>Dr. J. P. E. Morrison is of the opinion that *V. s magnidens* does not occur in Virginia. He identified material sent the U. S. National Museum from VA. 657, three miles west of Ashland, Hanover County, as *Ventridens cerinoideus* (Anthony).



at only three localities in the western Piedmont of Hanover County.

*Pupoides albilabris* (Adams), also a rare species, has been found in two localities in the Piedmont of Hanover County (Springfield Church, Va. Rt. 611, and Va. Rt. 657, one mile west of Ashland) and one locality in the Coastal Plain of Henrico County (White Oak Swamp Creek, Va. Rt. 802). It has been reported by P. R. Burch (1950) in Dinwiddie, Highland, and Norfolk counties. In this area it has been found associated only with oak-maple stands.

*Vertigo ovata* (Say) was found at several stations in the Piedmont province associated with oak-maple and oak-poplar stands. Although not found in the Coastal Plain of this area, it has been reported from Norfolk County (P. R. Burch, 1950).

#### FAMILY STROBILOPSIDAE

*Strobilops aenea* (Pilsbry) occurs frequently and is generally distributed over the entire area. This minute, dome-shaped species was found most commonly under the bark of fallen oak logs. When found in humus it was most frequent at a pH range of 6.3 - 6.7 and soil of very high calcium content.

*Strobilops labyrinthica* (Say), very similar to *S. aenea*, is not restricted to any particular region, but is scarce. It has been reported by P. R. Burch (personal communication) from Louisa, King William, and New Kent counties.

#### FAMILY VALLONIDAE

*Vallonia excentrica* (Sterki) was found only in the Piedmont of Hanover and Henrico counties and was rare. It has been reported from the Coastal Plain of Virginia by P. R. Burch (1950) in Norfolk County. It was found at a pH of 7.5 at the only station where soil analysis data are available for this species.

#### ORDER BASOMMATOPHORA

##### FAMILY CARYCHIIDAE

*Carychium exiguum* (Say), one of the smallest snails in the area (length, 1.6 mm.; width, 0.7 mm.), has been found occasionally in the Piedmont, associated only with stands where oaks are abundant. Specimens resembling *Carychium exile* Lea were also present in some lots, but recent work by Harry (1951) seems to indicate *C. exile* is merely a growth variant of *C. exiguum*.

#### SUMMARY

One hundred and ninety-seven collections from 123 stations have been made in Hanover, Henrico, and Chesterfield counties, Virginia, between June, 1952 and May, 1954. Thirty-four species and subspecies representing ten families and two orders have been determined and their distribution and abundance noted. Duplicate specimens have been deposited in the collections of Dr. Paul R. Burch, Rockville, Virginia, and in the United States National Museum, Washington, D. C.

## ACKNOWLEDGMENTS

I wish to thank Dr. Nolan E. Rice, University of Richmond, for criticism, encouragement, and advice in the development of this problem. I am indebted to Dr. Henry A. Pilsbry, Curator of Mollusks, Academy of Natural Sciences of Philadelphia, for identifying *Gastrocopta pentodon* (Say) and *Ventridens suppressus magnidens* Pilsbry; Dr. J. P. E. Morrison, Associate Curator of Mollusks, United States National Museum, Washington, D. C., for identifying *Anguispira fergusonii* (Bland), *Euconulus dentatus* Sterki, *Retinella burringtoni* (Pilsbry), and *Retinella indentata* (Say), and for critically checking some of my material; and Dr. Paul R. Burch, formerly Professor of Biology, Radford College, Virginia Polytechnic Institute, for information concerning land snail distribution in Virginia. Grateful acknowledgement is made to the Research Committee of the Virginia Academy of Science for a research grant which helped meet the financial demands of this problem.

## LITERATURE CITED

- BLOOMER, ROBERT OLIVER 1938. The Geology of the Piedmont in Chesterfield and Henrico Counties, Virginia. *M. S. Thesis, U. Va.*, p.8.
- BURCH, JOHN BAYARD 1952. A Preliminary List of the Mollusca of Hanover County Virginia. *Naut.*, 66(2):60-63.
1954. The Land Snails of Henrico County, Virginia. *Naut.*, 68(1):30-33.
- BURCH, PAUL R. 1950. Mollusks. In: The James River Basin Past, Present, and Future. *Va. Acad. Sci.*, 129-137.
- DICE, LEE R. 1952. Natural Communities. *U. Mich. Press.*, 34-44.
- HARRY, HAROLD W. 1951. *Carychium exiguum* (Say) of Lower Michigan; Morphology, Ecology, Variation and Life History (Gastropoda, Pulmonata). *Ph.D. Dissertation. U. Mich.*
- HUBRICHT, LESLIE. 1953. Land Snails of the Southern Atlantic Coastal Plain. *Naut.*, 66(4): 114-125.
- INGRAM, W. M. 1941. Habits of Land Mollusca at Rensselaerville, Albany County, New York. *Amer. Mid. Nat.*, 23(3):644-651.
- LATIMER, W. J. AND M. W. BECK. 1913. Soil Survey of Henrico County, Virginia. *U. S. Dept. Agr.*, p. 145.
- LEE, C. BRUCE. 1952. Ecological Aspects of *Stenotrema hirsutum* (Say) in the Region of Ann Arbor, Michigan. *Amer. Mid. Nat.*, 47(1):55-60.
- PILSBRY, HENRY A. 1939-48. Land Mollusca of North America (North of Mexico) *Acad. Nat. Sci. Phila.*, 1 and 2:1-2215 + xxvi.
- REHDER, H. A. 1949. Some Land and Freshwater Mollusks from the Coastal Region of Virginia and North and South Carolina. *Naut.*, 62(4): 121-126.

## News and Notes

### AGRICULTURAL SCIENCE SECTION

Dr. F. D. Hansing, who has been working in cooperation with staff members of the Department of Agricultural Economics at Virginia Polytechnic Institute, was transferred by the U. S. Department of Agriculture to the University of Delaware, effective April 30, 1955.

Dr. J. S. Plaxico resigned from Virginia Polytechnic Institute March 12 to accept a position in the Department of Agricultural Economics at Oklahoma Agricultural and Mechanical College.

Mrs. Marguerite N. Horn, Instructor of Rural Sociology at Virginia Polytechnic Institute, has resigned, to be effective June 5, 1955. Her husband, Dr. Herman Horn, will become Superintendent of Roanoke County Public Schools.

Andrew Jackson Lambert, Agricultural Engineering Graduate of Virginia Polytechnic Institute, 1950, has joined the Agricultural Engineering Department Staff as Associate Extension Agricultural Engineer. Lambert served as rural representative for the Appalachian Electric Power Company at Rocky Mount, Virginia for four years. He is devoting most of his time to the Extension program in rural electrification.

Homer T. Hurst has been appointed Associate Agricultural Engineer in the Research Division of the Agricultural Engineering Department. Hurst is a native of Arkansas and received his B.S. and M.S. degrees in Agricultural Engineering at Ohio State University in 1950 and 1951 respectively. He did structures research work for the Ohio Experiment Station prior to coming to Virginia Polytechnic Institute on March first. Hurst's work at Virginia Polytechnic Institute will be on farm structures research.

James H. Strickler has been appointed Associate Agricultural Engineer to serve as Coordinator for the Virginia Farm Electrification Council, a position on the Agricultural Engineering Department Staff. Strickler received his B.S. degree in Agricultural Engineering at Virginia Polytechnic Institute in 1951 and since then had been employed in rural electrification work with T. V. A. His appointment was effective May 2.

The Virginia Farm Electrification Council reelected E. T. Swink, Head, Agricultural Engineering Department and H. W. Sanders, Head, Vocational Education Department at Virginia Polytechnic Institute, for its Chairman and Vice Chairman, respectively, for 1955-56. The annual business meeting of the Council was held in Richmond on May 11.

Dr. Robert F. Kelly has been appointed by the Animal Husbandry Department at Virginia Polytechnic Institute to direct the work in meats research and teaching. Dr. Kelly received his training at the University of Wisconsin.

Recent publications from the Biochemistry and Nutrition Department at Virginia Polytechnic Institute include the following: Nutrients in Soils and Plants. Minor Element Content of Forage Plants and Soils. *Journal of Agri-*



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*cultural and Food Chemistry* 3, pp. 226-229, March, 1955. N. O. Price, W. N. Linkous and R. W. Engel. Minor Element Content of Forage Plants from the Coastal Region of Virginia. *Virginia Agricultural Experiment Station Technical Bulletin* 123, April, 1955. N. O. Price, W. N. Linkous and R. W. Engel, Department of Biochemistry and Nutrition.

WESLEY P. JUDKINS, *Virginia Polytechnic Institute*

## ENGINEERING SECTION

Mr. Tilton E. Shelburne of the Virginia Council for Highway Investigation and Research attended a meeting on May 9 in Chicago of the Working Committee on design of a test road of the American Association of State Highway Officials. On May 25 he attended a meeting of Department Chairmen of the Highway Research Board in Washington. Mr. Shelburne is Chairman of the Design Department.

Professor Lawrence R. Quarles, Assistant Dean of the Engineering School of the University of Virginia, attended the ASEE Southeastern district meeting in Knoxville, Tennessee on April 14-16. On May 25 he attended an invitational meeting at Penn. State University to discuss university nuclear reactors. This meeting was held under the auspices of the National Research Council Subcommittee on Unclassified Reactors. Professor Quarles has been instrumental in establishing the degree Doctor of Science in Engineering-Physics which was approved during May by the University of Virginia.

Professor R. E. L. Gildea of the Civil Engineering Department, University of Virginia, and Mr. Phillip Melville of the Virginia Council for Highway Investigation and Research attended the joint meeting of the Student Chapters of the ASCE at Lexington, Virginia on May 6. Professor Robert M. Hubbard of the Chemical Engineering Department, University of Virginia, attended the meeting of the AIChE held in Louisville, Kentucky in March.

Professor Robert W. Truitt of the Aeronautical Engineering Department, Virginia Polytechnic Institute, has recently completed a research project for the Air Force on "Investigation of Wedges in Transonic Flow." Dean John W. Whittemore of Virginia Polytechnic Institute attended the Industrial Management Conference on March 18 held under the sponsorship of the Virginia Manufacturers' Association, Virginia Military Institute, and Washington and Lee University. Professor Dan Frederick of the Applied Mechanics Department, Virginia Polytechnic Institute, received the Ph.D. degree in Engineering Mechanics from the University of Michigan in February.

Professor Nelson F. Murphy of the Chemical Engineering Department, Virginia Polytechnic Institute, presented a paper on "Two Film Theory in Liquid-Liquid Extraction" at the Houston, Texas meeting of the AIChE, on May 2. Professor Murphy escorted chemical engineering students to the

corrosion research laboratories of the International Nickel Company near Wrightsville Beach, North Carolina on May 20. Professor Dale S. Davis, also of this chemical engineering department, presented a paper called "Industrial Nomography" before the Engineering Drawing Division of the ASEE in Knoxville, Tennessee on January 28. Professor Davis recently had published by Reinhold Publishing Corporation a text entitled "Nomography and Empirical Equations." Professor Dudley Thomson, also of this chemical engineering department, has been awarded a grant of \$4,100 by Socony-Vacuum Oil Company to support research on the effects of ultrasonic energy on mass transfer in liquid-liquid extraction.

The George Washington Engineering Award has been presented for three successive years by the Engineering Section as a result of the generous enthusiasm of various engineers throughout the State of Virginia. The inception of this award resulted from the excellent projects showing engineering ability on the part of Junior Academy members. The substance of the award is not only the scroll shown above but also a cash prize. In addition the complimentary efforts of the Senior engineers reflect themselves in counsel and encouragement for the Juniors to pursue their projects. Guidance into college or technical employment is a common result for the winner and all other contestants.

## Virginia Academy Of Science George Washington Engineering Award 1957

Let it be known now and henceforth that  
**Walter Samuel Thomas**  
did best demonstrate in the year of Our  
Lord one thousand nine hundred and fifty  
four the talents for engineering ability be-  
fore this academy. In full recognition  
and with our compliments.  
The award committee

Phillip L. Melville  
Dudley Thompson  
Robert E. Mulford

George Washington, S.E.

Robert W. Sawitt  
Nelson J. Murphy  
Bernard A. Meisner



The winners of this award have been:

1952 — Gerald P. Waldborg

1953 — Floyd Wilson

1954 — Walter S. Thomas

—ROBERT M. HUBBARD, *University of Virginia*

### GEOLOGY SECTION

Nearly one hundred geologists representing colleges and universities, governmental agencies and private companies participated in the joint field conference held in Harrisonburg, Virginia, May 19-22, 1955. The conference was sponsored by the Virginia Division of Geology, the Appalachian Geological Society, and the West Virginia Geological Survey. The stratigraphy and structure of Pre-Cambrian and Paleozoic rocks between the east slope of the Blue Ridge and the Bergton gas field in Rockingham County were studied. One of the highlights of the conference was the trip through the Shenandoah Caverns.

*Geology of Bergton Gas Field, Rockingham County Virginia*, by Robert S. Young and Wilbur T. Harnsberger is being issued as Reprint Series No. 17 by the Virginia Division of Geology.

Porter J. Brown, geologist, United Fuel Gas Co. of Charleston, West Virginia, spoke to the Holden Society of Virginia Polytechnic Institute in connection with the Sixth Annual Engineering Conference held April 21-23. He emphasized practical aspects of exploring for oil and gas in the Appalachians.

Dr. R. M. Allen, manager of the French Coal Co., Bluefield, West Virginia, spoke to the Holden Society at the regular meeting held on May 10. His talk dealt with the composition and structure of certain coal beds in southern West Virginia.

Dr. Bruce Nelson will join the staff of the Virginia Polytechnic Institute Geology Department in September 1955. He will teach courses in mineralogy and geochemistry and also will devote part of his time to research in connection with the study of the clay deposits of Virginia.

Jonathan Edwards, Jr. is this year's recipient of the Holden Prize. The prize, a Brunton compass, is awarded annually to the Virginia Polytechnic Institute senior majoring in geology who has the highest scholastic standing. Edwards will be field assistant with The Texas Company in Montana before returning to Virginia Polytechnic Institute in the fall to work on his masters degree. Donald P. Moore was the winner of the Sophomore Achievement Award. This award, an Estwing geologic pick, is given to the Virginia Polytechnic Institute sophomore majoring in geology who from all standpoints has shown promise of contributing much to his profession.

The first *Additions to Virginia Mineral Localities* will be published by the Virginia Engineering Experiment Station, Blacksburg, Virginia, in October or November. R. V. Dietrich requests that any information concern-



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ing new mineral localities or corrections of material included in *Virginia Mineral Localities* be sent to him at the Department of Geology, Virginia Polytechnic Institute, Blacksburg, Virginia, so that they may be included in this new bulletin.

Dr. Troy J. Laswell of the geology department of Washington and Lee University will spend the summer working on photogeology for Humble Oil Co. John Alford and Alan Mixson, Washington and Lee students, will be engaged in exploration for uranium in the Yellowknife district of the Northwest Territory of Canada.

Wayne E. Moore of Virginia Polytechnic Institute will spend the summer studying the lithology and stratigraphy of the sediments of the Virginia Coastal Plain. This study is being made for the Virginia Division of Geology. Fletcher McCutcheon is stationed in Lewiston, Montana where he is employed by The Texas Company. Carl Meyertons is working for Stanolind and is stationed in Albuquerque, New Mexico. Both received their masters degrees from Virginia Polytechnic Institute in June.

—W. D. LOWRY, *Virginia Polytechnic Institute*

## PSYCHOLOGY SECTION

The Virginia Examining Board for Clinical Psychologists has recently certified the following: Alvis W. Jeffreys, Jr., of Western State Hospital, Mrs. Antonia Bess Morgan of Aptitude Associates, and Jacob Silverberg of McGuire Veterans Hospital. William M. Hinton was reelected chairman of the Examining Board. William E. Harris, Chief Clinical Psychologist at McGuire Hospital, was appointed to the Board to succeed Austin E. Grigg, who has resigned his position at the University of Richmond to continue graduate work at the University of Iowa. Richard H. Henneman was reelected to the Board. Other members of the Board at the present time are Miss Catherine T. Giblette of Richmond, and Dr. Gilbert J. Rich, Director of the Roanoke Guidance Center, and present Chairman of the Psychology Section.

Several Virginia psychologists were active on the program of the first meeting of the newly organized Southeastern Psychological Association, held in Atlanta, May 22-24. Frank W. Finger was moderator of a symposium, "The Teaching of Psychology in Colleges and Universities"; Stanley B. Williams spoke on psychology in the small liberal arts college, on this same symposium; Dr. Gilbert Rich was a panel speaker on a symposium, "The Roles of Psychological Organizations", speaking on the role of the state organization. Richard H. Henneman was panel speaker representing experimental psychology on a symposium, "Research in Progress". Morris Roseman presented a paper, "The Advantages and Disadvantages of the Co-therapy Method in Group Psychotherapy — the Opinions of Co-therapists". He was also co-author of another paper on the program, "A Graphic Method for Showing Therapeutic Change by the Use



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of MMPI Scales". Dr. Gilbert Rich also presented a paper, "The Psychologist in the Community Clinic Team as Seen by a Psychiatrist". William M. Hinton and Richard H. Henneman were chairmen of the sessions on the school psychologist, and on motivation, respectively.

Arrangements are now being completed for the Fourth Annual Seminar of the Roanoke Veterans Administration Hospital to be held on October 10 and 11. The subject of this year's seminar is "The Patient, the Hospital, the Community — The Integration of the Psychiatric Hospital and the Community".

At the annual business meeting of the Richmond Psychological Association, on May 20, the following officers were elected for the forthcoming year: Robert Filer, president; Jack Silverberg, vice president; Ann Hardesty, secretary-treasurer. James T. Grayley will leave the Educational Therapy Center, Richmond, in August, to attend the University of Maryland, working toward his Ph.D. in counseling psychology. John Williams, Ph.D., University of Iowa, will join the staff at the University of Richmond in September. Charles E. Peachee, formerly psychologist at Central State Hospital, Petersburg, assumed his duties as staff psychologist at Westbrook Sanitarium, Richmond, on June 1. Mrs. Catherine Giblette recently retired from her position as chief psychologist at the Memorial Guidance Clinic in Richmond. She is continuing her psychological work in private practice.

Burton R. Wolin left the College of William and Mary February 1 to take a research position with the Rand Corporation, Santa Monica, California. Miss Ernestine Cox took his place during the past semester as acting instructor. Peter M. Guthrie of Brown University has been appointed to an assistant professorship in psychology for 1955-56. John Bare and Stanley B. Williams are continuing a research project at William and Mary this summer for the Air Force on operator efficiency as a function of scope size.

Walter A. Woods, of the Richmond Professional Institute School of Clinical and Applied Psychology, is leaving to accept a Veterans Administration appointment at Lyons, New Jersey. Other changes in the RPI staff include William R. Reeve, who is leaving at the end of the summer to accept a position at Oregon University; Robert Corder, who joined the staff as associate professor in February, will continue next year; Edwin S. Thomas, completing his Ph.D. at Syracuse University, will join the RPI staff in September.

Morris Roseman of the Veterans Administration Hospital, Roanoke, has been appointed Chief Clinical Psychologist at the Veterans Administration Mental Hygiene Clinic in Baltimore, and will assume his duties there sometime during the summer.

Dr. Frederick S. Hauser, Assistant Professor of Psychology at Hollins College, has accepted a position in New York City with George Fry and Associates as a consultant psychologist.

William M. Hinton of Washington and Lee, and Robert C. Wingfield of Converse College will be members of the Summer School staff in psychol-

ogy at the University of Virginia. Frank A. Geldard will continue to direct research on vibratory sensitivity of the skin on a contract for the Office of Naval Research. Richard H. Henneman is director of a research contract on complex decision-making behavior for the Surgeon General's Office of the Army. Frank W. Finger and L. Starling Reid have received a grant from the National Science Foundation for research on patterns of response to food and water deprivation in the rat.

Miss Hannah Davis is expected to return to the Lynchburg State Colony this summer following her leave of absence. Mrs. William McConnell is leaving the Lynchburg Guidance Center to do graduate study at the University of Pittsburgh. Miss Marjorie Brownell will return to Randolph-Macon Woman's College after a year of advanced study at the University of Massachusetts. Paul Mountjoy will be an acting member of the psychology department at Sweet Briar College during the 1955-56 session.

RICHARD H. HENNEMAN, *University of Virginia*

#### STATISTICS SECTION

Dr. R. A. Bradley returned to his position as Professor of Statistics at the Virginia Polytechnic Institute June 1, 1955, from Rutgers University where he was a visiting professor. He will present a series of seminars at the Southern Regional Graduate Summer Session in Statistics which will be held at the University of Florida this summer. Dr. Bradley gave a paper at the convention of the American Society for Quality Control entitled "Statistical Designs for Taste Test Panels". His papers, "Some Notes on the Theory and Application of Rank Order Statistics, Parts I and II," were published in the February and March issues of *Industrial Quality Control*. Dr. Bradley is going to Rutgers University September 10 to take part in the Rutgers All-Day Convention on Statistics.

Dr. Boyd Harshbarger and Dr. R. A. Bradley visited the Oak Ridge Institute of Nuclear Studies to discuss the progress of R. G. Cornell's dissertation and reported that definite progress is being made.

Dr. Boyd Harshbarger is teaching Design of Experiments at the Southern Regional Graduate Summer Session held at the University of Florida, Gainesville, Florida.

Dr. W. A. Thompson, Jr. will resign his position as Associate Professor of Statistics at the Virginia Polytechnic Institute June 30 to accept a position in El Paso, Texas.

Dr. R. L. Wine joined the staff of the Virginia Polytechnic Institute as an Associate Professor of Statistics on April 15, 1955. Dr. Wine studied at Bridgewater College, the University of Virginia, the University of Michigan, and received his Ph.D. degree from the Virginia Polytechnic Institute. His dissertation was entitled "A Power Study of Multiple Range and Multiple F Tests." He has published a paper entitled "Some Air War Games",



Engineering Research Institute, University of Michigan, Ann Arbor, Report No. M965 R-2.

Dr. R. J. Freund joined the staff of the Virginia Polytechnic Institute as an Associate Professor of Statistics June 1. Dr. Freund has studied at the University of Chicago and North Carolina State College. He completed and received his Ph.D. degree from the North Carolina State College. His publications include "A Statistical Investigation of the 1949 North Carolina Grain Survey"; "The Selection of Optimal Farm Enterprises: a Case Study in Linear Programming" with Dr. R. A. King; "A Procedure for Solving a Linear Programming Problem" with Dr. R. A. King.

Mr. D. P. Morton will join the staff of the Statistics Department of the Virginia Polytechnic Institute September 1, 1955. He received his formal training at the McGuire's University School and the Virginia Polytechnic Institute. Mr. Morton is a registered Professional Engineer (Mining and Mechanical) and has written numerous technical articles and papers. He has worked in Virginia and West Virginia coal fields as mine superintendent. Mr. Morton has been Chief Rating Commissioner with the Chesapeake and Ohio Railroad and has been very active in forecasting and statistical work.

Dr. J. E. Freund and Mr. Irwin Miller published a paper entitled "In Defense of Frequencies" in the *American Statistician*, April 1955.

The following members of the Statistics Section received their M.S. degrees in statistics from the Virginia Polytechnic Institute on June 5, 1955: E. L. Bombara, Leo Lynch, Kamini Patwary, A. N. Pozner, R. L. Taylor, and Dan Zakich.

Mr. Norbert L. Enrick of the Institute of Textile Technology, Charlottesville has recently published the following: "Quality Control", Second Revised Edition, The Industrial Press, N. Y.; "Quality Control through Statistical Methods; Specifically Designed for Textile Mills", Modern Textiles Magazine; "Modern Mill Controls", Modern Textiles Magazine; "Making Best Use of Sampling Inspection", Plant Administration; and "Statistical Quality Control in Textile Processing", Amer. Soc. for Quality Control, Textile Division (Copies of the latter may be obtained from Mr. Enrick.

LIONEL WEISS, *University of Virginia*



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### NOTICE TO CONTRIBUTORS

Contributions to the Journal should be addressed to Horton H. Hobbs, Jr., Biology Laboratory, University of Virginia, Charlottesville, Virginia. If any preliminary notes have been published on the subject which is submitted to the editors, a statement to that effect must accompany the manuscript.

Manuscripts must be submitted in triplicate, typewritten in double spacing on standard 8½" x 11" paper, with at least a one inch margin on all sides. Manuscripts are limited to seven pages, with the proviso that if additional pages are desired, the author may obtain them at cost.

Division of the manuscript into subheadings must follow a consistent plan, and be held to a minimum. It is desirable that a brief summary be included in all manuscripts.

Footnotes should be included in the body of the manuscript immediately following the reference, and set off by a dashed-line above and below the footnote content. Footnotes should be numbered consecutively from the beginning to the end of the manuscript.

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Explanations of figures, Graphs, etc., should be typed on separate pages. All figures should be numbered consecutively beginning with the first text figure and continuing through the plates. If figures are to be inserted in the text this should be clearly indicated by writing "Figure —" at the appropriate place in the margin.

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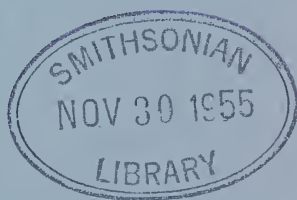
# THE VIRGINIA JOURNAL OF SCIENCE

A JOURNAL ISSUED QUARTERLY BY THE  
VIRGINIA ACADEMY OF SCIENCE

AHC

PROCEEDINGS FOR THE YEAR

1954 — 1955





VOL. 6, NEW SERIES

SEPTEMBER, 1955

No. 4

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THE VIRGINIA JOURNAL OF SCIENCE

VOL. 6, NEW SERIES

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# VIRGINIA ACADEMY OF SCIENCE



Proceedings for the Year  
1954--1955

MINUTES OF THE THIRTY-THIRD ANNUAL MEETING

MAY 11, 12, 13, 14, 1955

AT MADISON COLLEGE

HARRISONBURG, VIRGINIA

## LIST OF PRESIDENTS

IVEY F. LEWIS .....	1923-24
JAMES LEWIS HOWE .....	1924-25
ROBERT E. LOVING .....	1925-26
*J. SHELTON HORSLEY .....	1926-27
*DONALD W. DAVIS .....	1927-28
WM. MOSELEY BROWN .....	1928-29
GARNETT RYLAND .....	1929-30
L. G. HOXTON .....	1930-31
I. D. WILSON .....	1931-32
T. McN. SIMPSON, JR. ....	1932-33
WILLIAM A. KEPNER .....	1933-34
WILLIAM T. SANGER .....	1934-35
IDA SITLER .....	1935-36
H. E. JORDAN .....	1936-37
D. MAURICE ALLAN .....	1937-38
EARLE B. NORRIS .....	1938-39
RUSKIN S. FREER .....	1939-40
*WORTLEY F. RUDD .....	1940-41
GEORGE W. JEFFERS .....	1941-42
MARCELLUS H. STOW .....	1942-43
*W. CATESBY JONES .....	1943-44
ROBERT F. SMART .....	1944-45
H. RUPERT HANMER .....	1945-46
ARTHUR BEVAN .....	1946-47
JESSE W. BEAMS .....	1947-48
SIDNEY S. NEGUS .....	1948-49
BOYD HARSHBARGER .....	1949-50
GUY W. HORSLEY .....	1950-51
PAUL M. PATTERSON .....	1951-52
LLOYD C. BIRD .....	1952-53
ALLAN T. GWATHMEY .....	1953-54
IRVING G. FOSTER .....	1954-55
WALTER S. FLORY, JR. ....	1955-56

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\* Deceased.

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Astronomy, Mathematics, and Physics: J. Gordon Stipe, Chairman; Melvin A. Pittman, Secretary; Frank L. Hereford, Section Editor (1956).

Bacteriology: A. L. Rosensweig, President; Wesley Volk, Vice-President; Mrs. Barbara H. Caminita, Secretary-Treasurer; P. Arne Hanson, Section Editor (1956).

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George W. Jeffers	W. T. Ham, Jr.	Lorin A. Thompson
Allen Gwathmey	Ladley Husted	Boyd Harshbarger
	Henry Leidheiser	

#### RESEARCH

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R. C. Krug (1956)	Robert T. Brumfield (1958)
R. A. Bradley (1959)	

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Roscoe Hughes	H. J. Welshimer	Gilbert J. Rich
	J. S. Pierce	

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Sidney S. Negus

L. W. Webb, Jr.

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W. W. Nobb  
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Elizabeth Perry

Alfred L. Wingo  
Percy H. Warren  
I. D. Wilson

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Washington and Lee University, Lexington

Robert P. Carroll  
Ivey F. Lewis

A. B. Massey  
Charles T. O'Neill

Foley F. Smith  
I. D. Wilson

#### JAMESTOWN EXPOSITION

Marcellus Stow, *Chairman*

Horton H. Hobbs

W. G. Guy

#### AWARDS COMMITTEE

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Virginia Polytechnic Institute, Blacksburg

Sidney S. Negus

George W. Jeffers

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Mary E. Kapp (R. P. I.), Registration

Lewis F. Taylor (Phipps & Bird), Meeting Rooms and Equipment

Russell J. Rowlett, Jr. (Virginia-Carolina Chemical Corp.), Public Information

E. Sherman Grable (U. of Richmond), Junior Academy Exhibits

W. Schuyler Miller (Randolph-Macon), Commercial Exhibits

Robert F. Smart (U. of Richmond), Biology Field Trip

R. P. Hackney (American Tobacco Co., Research Lab.), Chemical Industry Tours

William M. McGill (Virginia Geological Survey), Geology Field Trip

Roscoe D. Hughes (Medical College of Virginia), Signs, Maps and Parking

Mrs. William R. Harlan and Mrs. Edward S. Harlow, Entertainment for Ladies

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## JEFFERSON MEDAL WINNERS

RECIPIENTS OF THE JEFFERSON GOLD MEDAL <sup>1</sup>

Alfred Chanutin .....	1936
William B. Porter .....	1937
H. M. Phillips .....	1938
G. M. Shear and H. D. Ussery .....	1939

RECIPIENTS OF THE JEFFERSON PRIZE <sup>2</sup>

L. G. Overholzer and John H. Yoe .....	1940
Allan T. Gwathmey .....	1941
R. N. Jefferson .....	1942
W. H. Hough .....	1943
Clinton B. Cosby .....	1944

## RECIPIENTS OF J. SHELTON HORSLEY RESEARCH AWARDS

Carl C. Speidel .....	1927
John H. Yoe .....	1928
J. C. Street .....	1929
H. E. Jordan	
Carl C. Speidel .....	1930
E. C. Stevenson .....	1931
James H. Smith .....	1932
S. A. Wingard .....	1933
E. P. Johnson .....	1934
Margaret Hess .....	1935
Alfred Chanutin .....	1936
R. G. Henderson .....	1937
S. G. Bedell .....	1938
M. J. Murray	
F. F. Cleveland .....	1939
Walton C. Gregory .....	1940
Charles Ray .....	1941
No Award .....	1942
J. B. Meyer .....	1943
J. H. Taylor .....	1944
No Award .....	1945
Boyd Harshbarger and	
D. B. DeLury (separate papers) .....	1946
No Award .....	1947
Henry Leidheiser, Jr. ....	1948

<sup>1</sup> The winning papers in this competition were entered against those of the North Carolina, South Carolina, Georgia, and Florida Academies of Science. It was discontinued in 1940.

<sup>2</sup> The winning authors had the choice of the Jefferson Prize or the Academy Prize during this period. The name of the Academy Prize was changed to the J. Shelton Horsley Award and the Jefferson Prize discontinued in 1944.



Walter S. Flory, Jr. ....	1949
Erling S. Hegre .....	1950
David B. Duncan .....	1951
D. R. H. Gourley .....	1952
Stephen Berko	
Frank L. Hereford .....	1953
Lynn D. Abbot, Jr. and Mary J. Dodson .....	1954
Albert W. Lutz .....	1955

***General Program of  
The Thirty-Third Annual Meeting  
1 9 5 5***

WEDNESDAY, MAY 11

5:00 P.M. to 10:00 P.M.—Registration for Junior Academy Members, Participants in the Science Talent Search—Foyer, Madison Memorial Library.

5:00 P.M. to 10:00 P.M.—Arranging Exhibits—Burruss Science Hall.

THURSDAY, MAY 18

8:00 A.M. to 5:00 P.M.—Registration for Junior Academy Members, Senior Academy Members and Guests—Foyer, Madison Memorial Library.

9:00 A.M.—Meeting of Science Exhibit Judges, Science Talent Search Judges—Burruss Science Hall, Rooms 201, 209.

9:30 A.M.—Meeting of Chairman and Exhibitors, and Science Talent Search Participants—Burruss Science Hall, Room 109.

10:00 A.M. to 12:30 P.M. and 1:30 P.M. to 4:00 P.M.—Finalists of Talent Search meet with Chairman and Interviewers—Burruss Science Hall, Rooms 2, 7, 307, 308.

10:00 A.M. to 12:30 P.M. and 1:30 P.M. to 4:00 P.M.—Judging of Science Exhibit Contests—Burruss Science Hall.

1:00 P.M. to 2:00 P.M.—Luncheon.

2:00 P.M.—Meeting of the Council of the Academy—Burruss Science Hall, Room 103.

4:00 P.M.—Meeting of all Senior Academy Section Officers—Burruss Science Hall, Room 109.

4:30 P.M.—Meeting of the Section Editors—Burruss Science Hall, Room 209.

5:00 P.M.—Meeting of Virginia Junior Academy of Science Committee—Burruss Science Hall, Room 11.

7:00 P.M.—Business Meeting, Junior Academy of Science—Wilson Hall, Auditorium.

7:30 P.M.—Address of Guest Speaker for Junior Academy Members and Guests—Wilson Hall, Auditorium.

8:30 P.M.—Senior Academy Conference and General Meeting—Wilson Hall, Auditorium.

## FRIDAY, MAY 13

8:30 A.M.—Registration.

9:00 A.M.—Section Meetings: (See detailed sectional programs below for exact hour.)

Agricultural Sciences—Wilson Hall—Room 28

Astronomy, Mathematics, Physics—Burruss Science Hall—Room 11

Bacteriology—Burruss Science Hall—Room 311

Biology—Burruss Science Hall—Room 109

Chemistry—Wilson Hall—Auditorium

Education—Wilson Hall—Room 27

Engineering—Burruss Science Hall—Room 201

Geology—Burruss Science Hall—Room 209

Medical Sciences—Wilson Hall—Room 25

Psychology—Wilson Hall—Rooms 21 and 32

Science Teachers—Burruss Science Hall—Room 103

Statistics—Burruss Science Hall—Room 301

10:00 A.M. to 11:30 A.M.—Symposium, "What's New in Chemistry," sponsored by Science Teachers Section—Burruss Science Hall, Room 103.

12:00 noon to 1:00 P.M.—Junior-Senior Scientist Hour *at which awards will be presented*—Wilson Hall, Auditorium.

1:00 P.M. to 2:00 P.M.—Luncheon.

2:00 P.M.—Section Meetings.

4:45 P.M. to 6:00 P.M.—Madison College will be host at a tea to the Members and Guests of the Academy—Alumnae Hall Parlor.

7:45 P.M.—Short Business Meeting, Senior Academy—Wilson Hall, Auditorium.

8:30 P.M.—Address by Mr. Jerome Namias, Chief, Extended Forecast Section. U. S. Weather Bureau—Wilson Hall, Auditorium.

## SATURDAY, MAY 14

9:00 A.M.—Section Meetings.

10:00 A.M.—Academy Council Meeting—Burruss Science Hall, Room 103.



## Tabulation of Registration

	<i>Section</i>	<i>Members</i>	<i>Non-Members</i>	<i>Total</i>
1.	Agricultural Sciences .....	25	9	34
2.	Astronomy, Mathematics & Physics	34	14	48
3.	Bacteriology .....	2	0	2
4.	Biology .....	68	17	85
5.	Chemistry .....	53	38	91
6.	Education .....	9	4	13
7.	Engineering .....	9	16	25
8.	Geology .....	24	16	40
9.	Medical Sciences .....	10	6	16
10.	Psychology .....	28	13	41
11.	Science Teachers .....	14	1	15
12.	Statistics .....	18	2	20
	No Section Preference .....	12	26	38
<hr/>				
	Total .....	306	162	468

## MINUTES OF THE MEETING OF THE COUNCIL, CHARLOTTESVILLE, MARCH 13, 1955

A meeting of the Council of the Virginia Academy of Science was held in the Conference Room, Alderman Library, University of Virginia, March 13, 1955.

President I. G. Foster called the meeting to order at 2:00 P.M. Present were: Lloyd C. Bird, James W. Cole, Byron W. Cooper, President-Elect Walter S. Flory, Jr., Allan T. Gwathmey, Ed Harlow, Boyd Harshbarger, William Hinton, Horton H. Hobbs, Sidney S. Negus, and Foley F. Smith.

Also present were George W. Jeffers, Ladley Husted, and J. E. Ikenberry, Chairman of the Local Committee on Arrangements, for the Madison College meeting, and William B. Wartman, Jr.

As the first item of business, Mr. Ikenberry discussed the meeting and housing arrangements, and advised the Council that everything possible was being done to make the Harrisonburg meeting a successful one.

President Foster told the Council that the guest speaker for the May meeting would be Mr. Jerome Namias, Chief, Extended Forecast Section U. S. Weather Bureau.

It was announced that Mrs. B. G. Heatwole was working on the project of following up the careers of former State Science Talent Search winners through the Academic Department of the University of Virginia, and not directly as an Academy project.

The Secretary informed the Council that the AAAS Council at the Berkeley, California meeting had approved the recommendations of the Policy Committee to liberalize the use of the AAAS research grant made to the State Academies on the basis of fifty cents per Academy member who is also a member of the AAAS. This previously could be used only for research projects by senior members of the Academy, approved by the Research Committee; and now can be used for an individual project by a high school science student provided such project is approved by the Academy Research Committee; however, cannot be used for Science Fairs or Science Club activities.

Stanley Williams reported to the Council for the Place of Meeting Committee, and recommended that the 1956 meeting of the Academy be held at the Hotel Roanoke, Roanoke, and that the 1957 meeting be held in Richmond, in conjunction with Jamstown-Williamsburg-Yorktown Celebration, which will take place in 1957.

Edward Harlow, Chairman of the Long-Range Planning Committee, reported on the problem of Secondary School Science Education. After considerable discussion entered into by all members present, it was decided the Academy should offer its services towards improving Science Teaching in the State, by asking for a joint conference with the State Board of Education. It was felt that the Academy should take the initiative in asking for this Conference and suggest it be made the type of meeting which

would best focus attention on science education in Virginia. Many phases were discussed; such as, what such a meeting would accomplish; summer jobs for teachers offered by industries; how many would be available for such jobs, and other problems offered by such a program. The President appointed James W. Cole, Chairman of a committee to study this problem, and report to the May meeting of the Council. It was moved, seconded and passed that Dr. Cole's statement made in his report of the Scientific Manpower Sub-Committee of the Long Range Planning Committee be adopted as the feeling of the Council in this matter. This statement is as follows:

"The Virginia Academy of Science occupies a highly important position in the Commonwealth of Virginia, and its influence extends throughout the Nation. This Association has never before been in a position where the need is so great for widely circulated statements of its policy on scientific conditions. It not only must clearly define its policy, but it must also suggest ways in which it can take positive action. In an attempt at summary statements might be: The Virginia Academy of Science expects to undertake new activities in Virginia to appraise the condition of science education, to encourage science education of high quality, and to insure an adequate supply of competent Science Teachers.

At the outset it might establish a new committee to gather information on science education, to define the problems, to outline the Academy's area of responsibility, and to suggest ways of meeting the problems. Such a meeting should make every effort to determine what other interested groups in the State are doing, and to cooperate with such groups where appropriate."

The resignation of Boyd Harshbarger as Editor-in-Chief of the Virginia Journal of Science was accepted with deep and sincere regret by the Council. Dr. Harshbarger served in this capacity for five years since the start of the new series. In fact, he was primarily responsible for the rebirth of the Journal and because of his efforts and activities, the Academy has much to be proud of, both from the financial status of the Journal and the quality of the papers that have been published.

Changes in the By-Laws concerning the Journal were approved by Council for recommendation to the Academy Conference in May. These changes were published on page 57, in the January issue of the Journal, Vol. 6, No. 1.

President Foster called for a meeting of the Council on Thursday, May 12, 1955, at 2:00 P.M. at Madison College; the meeting room to be announced later.

There being no further business the meeting adjourned at 4:00 P. M.

FOLEY F. SMITH, *Secretary*



## MINUTES OF THE COUNCIL MEETING, MAY 12, 1955

A meeting of the Council of the Virginia Academy of Science was held in Room 103, Burruss Science Hall, Madison College, Harrisonburg, at 2:15 P.M.

Present were: Lloyd C. Bird, William M. Hinton, Horton H. Hobbs, Jr., Boyd Harshbarger, Edward S. Harlow, L. W. Jarman, James W. Cole, Ladley Husted, Stanley B. Williams, Sidney S. Negus, Mrs. B. G. Heatwole, President-Elect Walter S. Flory, Jr., Marcellus Stow, and Foley F. Smith; President Irving S. Foster presided.

Minutes of the last meeting were read and approved. Kenneth Hyde, Associate Manager of the Hotel Roanoke, was present to invite the Academy to hold its 1956 meeting at the Hotel Roanoke, Roanoke; but it was found that due to conflicting dates, the hotel could not accommodate both the Senior and Junior Academies at a time suitable to the Academy. The place of meeting for 1956 was tabled until the Saturday meeting of the Council.

Marcellus Stow reported for the Committee for cooperating with the Jamestown Exposition for 1957 consisting of Horton Hobbs, and William Guy. It was the thought of Council that the Committee be continued to carry out suggestions made, concerning exhibits at the Exposition; revision and sale of the Academy Monograph, "The James River Basin—Past, Present and Future", and any special program to be held at the 1957 meeting.

Edward Harlow reported for Lloyd C. Bird, Chairman of the Finance Committee, and suggestions were made concerning increasing senior dues to four or five dollars with the elimination of the contributing membership classification. It was suggested that the incoming President appoint a committee of three to bring in suggestions to the Finance Committee, in regards to increasing the revenue of the Academy; this committee to report to the President at the 1956 meeting. This will include a survey of the present membership. This was moved, seconded and passed.

It was moved, seconded, and passed that the report and budget of the Finance Committee be accepted for recommendation to the Academy Conference.

Boyd Harshbarger briefly extracted the report of the Virginia Journal of Science for his five year term as Editor-in-Chief. This report will be included in the Proceedings. There was discussion concerning appointment of an Associate Editor. This appointment was tabled until the meeting of the Council Saturday.

It was moved, seconded, and passed that the Resolution Committee be authorized to draw suitable resolutions commending Professor Harshbarger for his five years of stewardship as Editor-in-Chief of the Journal.

It was moved, seconded, and passed, that the office of Assistant Secretary be created, but as an elected office, it would require a slight change

in the Academy Constitution, and this was also referred to the Saturday meeting of the Council.

James Cole reported as Chairman of a special committee on the Study of Science Education in Secondary Schools. It was moved, seconded, and passed that the report be accepted for recommendation to the Conference. This report is contained in the Proceedings.

There being no further business President Foster adjourned the meeting at 4:15 P.M.

FOLEY F. SMITH, *Secretary*

## MINUTES OF THE ACADEMY CONFERENCE, MAY 12, 1955

The Academy Conference was held in the Auditorium of Wilson Hall, Madison College, Harrisonburg, May 12, 1955. A quorum of more than forty members being present, the meeting was called to order at 9:15 P.M. by President Foster.

Recommendation of the Council concerning changes in By-Laws as printed on page 57, Vol. 6, No. 1, of the Virginia Journal of Science, was moved, seconded, and passed.

The report of the special study committee on Secondary Science Education was read and accepted by the Conference after considerable discussion, covering various phases of the problem ranging from monetary considerations to extra curricula school duties demanded of all teachers.

Reports of the various standing committees of the Academy were then called for and follow this report.

A letter was read inviting the Virginia Academy of Science to visit the Nature Trail, off route 250, west of Staunton, on the road to Monterey.

There being no further business, the Conference adjourned at 10:40 P.M.

FOLEY F. SMITH, *Secretary*

## MINUTES OF THE ACADEMY MEETING, MAY 13, 1955

The meeting was called to order in the Auditorium, Wilson Hall, Madison College, Harrisonburg, at 7:45 P.M.

President Foster recognized Dr. Raymond Taylor, Assistant Executive Secretary of the American Association for the Advancement of Science. Dr. Taylor extended greetings from the AAAS to the Academy on its Thirty-third Annual Meeting, and spoke graciously of the value of the Virginia Academy of Science among the forty-two State Academies, and its place in the Academy Conference held at the Annual AAAS Meeting. He spoke of the 1955 meeting of the Association, which will be held in Atlanta December 26-31, the preliminary program of which will be in the June issue of "Scientific Monthly" and the May 27 issue of "Science."

Colonel R. C. Weaver reported for the Resolutions Committee, and it was moved, seconded, and passed that the Resolutions be accepted to be printed in the Proceedings.

The Sponsor scholarship award was announced. The University of Virginia scholarship at the Mountain Lake Biology Station, was awarded to Miss Samuella Crimm, Broadway High School, Broadway. The William and Mary Scholarship in Chemistry was awarded to Robert T. Horn, of Mount Vernon High School, Alexandria.

Paul Patterson reported for the Nominating Committee, and proposed the following slate, which was unanimously elected for the coming year:

President Walter S. Flory, Jr., Vice Director of the Blandy Experiment Farm, Boyce

President-Elect Edward S. Harlow, American Tobacco Company Research Laboratory, Richmond

Foley F. Smith, Secretary-Treasurer, Virginia A. B. C. Board, Richmond

Mrs. B. G. Heatwole, Staunton, was elected to the Council for a period of five years succeeding L. W. Jarman, whose term expired.

Chalmers L. Gemmill reported for the Research Committee, and announced that Dr. Albert W. Lutz, Jr., Department of Chemistry, William and Mary College, was awarded the J. Shelton Horsley award for 1955 for his paper with E. B. Reid, on "Clovane and B-Caryophyllene Alcohol." Unfortunately, Dr. Lutz was absent, so the check and certificate of award will be presented to him later.

Dr. Lionel Weiss received honorable mention for his paper presented before the Statistics Section, "Sequential Procedures that Control the Individual Probabilities of Coming to the Various Decisions."

President Foster introduced Dr. G. Tyler Miller, President of Madison College, who welcomed the Academy on behalf of the College and com-



mended the action of Dr. James W. Cole's Committee on Science Education for its interest in improving Science teaching. He indicated that Madison College was deeply concerned, since its primary function was to prepare students for teaching.

President Foster then gave formal recognition to Boyd Harshbarger, the retiring Editor-in-Chief, of the Virginia Journal of Science, and specifically noted the excellent financial condition of the Journal, having assets of approximately five thousand dollars.

The business session was adjourned, and the guest speaker of the evening, Jerome Namias, Chief of the Extended Forecast Section, U. S. Weather Bureau, was introduced. Mr. Namias gave a very interesting and entertaining talk on long range weather forecasting all over the world; and his address was followed by a very lively question period, after which the meeting adjourned.

FOLEY F. SMITH, *Secretary*

## THE MINUTES OF THE COUNCIL MEETING, MAY 14, 1955

A meeting of the Council of the Virginia Academy of Science was held in Room 103, Burruss Science Hall, Madison College, Harrisonburg. President Walter S. Flory, Jr. called the meeting to order at 10:00 A.M. Present were: William N. Hinton, Stanley S. Williams, Allan T. Gwathmey, Sidney S. Negus, Edward S. Harlow, Irving G. Foster, and Foley F. Smith.

Horton H. Hobbs, Jr., of the Department of Biology, University of Virginia, was unanimously elected Editor of the Virginia Journal of Science. B. F. D. Runk, also of the University of Virginia, was elected Managing Editor, both terms to be for five years. It was moved, seconded, and passed that Mary E. Humphreys, Mary Baldwin College, Staunton, be commended by the Council for her able work as Associate Technical Editor of the Journal during the past five years. Dr. Humphreys with Richard W. Irby, Jr. were re-appointed to the staff of the Journal.

It was suggested that the Finance Committee consider surplus funds of the Journal in view of possibly limiting the surplus to be held by the Journal from year to year.

It was decided that since Hotel Roanoke, Roanoke, could not accommodate the Academy in May 1956, an invitation extended by the Richmond Area University Center, through its Administrator, Colonel Herbert W. K. Fitzroy, be accepted. Sidney Negus, Stanley B. Williams, and L. W. Webb, Jr. were appointed a committee to recommend a meeting place in the Jamestown area for 1957.

The President was authorized to appoint a committee as recommended in Dr. James W. Cole's report on Secondary Science Education to continue this most important study.

Lynn D. Abbott, Jr., Medical College of Virginia, was appointed Chairman of the Long Range Planning Committee to succeed Edward S. Harlow, President-Elect.

It was moved, seconded and passed that a special Committee be appointed by the President to investigate further sources of revenue for the Academy; this Committee to work with the Finance Committee in making a study of present revenues and to report at the next annual meeting of the Academy.

It was moved, seconded, and passed that Article 5 of the Constitution titled "Officers" be changed to include the office of Assistant Secretary. This article now reads, "the officers of this organization shall consist of the President, President-Elect, and Secretary-Treasurer". This will be changed to read, "the officers of this organization shall consist of the President, President-Elect, Secretary-Treasurer, and Assistant Secretary." The publication of this change in the Virginia Journal of Science will constitute proper notice to the membership for consideration at the next Academy Conference.

It was decided that an Awards Committee to consider eligibility for

Honorary membership in the Academy and other similar matters be instituted.

Sidney Negus suggested that the senior scientists be specifically invited to view the Junior Academy exhibits at the Annual meeting and to discuss with the students their projects and exhibits. He further suggested that the time now allotted on the Senior program for Junior activities be eliminated.

It was moved, seconded, and passed that Honorable Mention be given for the J. Shelton Horsley award, at the discretion of the Research Committee, and that the sum of fifty dollars be given to the author of the paper receiving such Honorable Mention.

Consideration was given the matter of changing the name of the present Committee on Resource-Use Education to the Committee on Conservation, but it was decided that this matter would be left to this committee for its decision.

It was recommended that the section secretaries make an effort to increase the number of papers on their programs, so that section meetings would continue through Saturday morning wherever feasible. It was also suggested that effort be made to develop more interest in the Academy Conference and that a formal program at this meeting might achieve this objective.

It was moved, seconded, and passed unanimously that the official thanks and appreciation be given Past-President Irving G. Foster for his work for the Academy during his year as President.

There being no further business, President Flory adjourned the meeting at 11:50 A.M.

FOLEY F. SMITH, *Secretary*



## REPORT OF THE SECRETARY-TREASURER

This, the thirty-third meeting of the Virginia Academy of Science, represents the second new fiscal or calendar year, but is the first full calendar year, representing the business of the Academy from December 31, 1954, to January 1, 1955. This change has increased the efficiency of all business affairs of the Academy.

The audit and report of the Finance Committee follows, and will also present the budget for 1955.

The various sections of the Academy for this year availed themselves of the addressograph service by which individual sections can have envelopes and membership lists made for their mailing at minimum expense and trouble.

### AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE MEETING

Your secretary represented the Academy at two Council meetings of the AAAS at the University of California, Berkeley, December 27 and 30, 1954. This, the 121st meeting of the Association, was the largest diversified scientific meeting ever held on the Pacific Coast, and the first time in many years that the Association has had a full meeting on the campus of a University.

Elected to the office of President-Elect of the Association was Paul B. Sears to succeed George W. Beadle, Professor of Biology, California Institute of Technology, the incoming President. The Council elected Chauncey D. Leake, educator and author; and Margaret Mead, anthropologist, for four year terms on the Board of Directors.

### THE ACADEMY CONFERENCE

The Conference of State Academies of Science is held in conjunction with the AAAS meeting. The Virginia Academy was represented at the Conference on December 30, 1954, by the Secretary and Mrs. B. G. Heatwole. Wayne Taylor, of the Texas Academy of Science, retiring President, acted as presiding officer for all sessions of the Conference in the absence of President-Elect Leland Taylor, of the Kentucky Academy.

Mrs. Heatwole, as Chairman of the Committee, presented a most excellent and comprehensive report to the Conference on the activities and operation of the Junior Academies throughout the country. The Virginia Academy was further honored by the election of Mrs. Heatwole as Secretary of the Conference for the coming year.

Your Secretary was a member of the Committee on Financial Policies and Practices of the Academies, and in the absence of Chairman Percival Robertson, of Princeps College, read the report of this committee.

Dr. Clinton L. Baker, of the Tennessee Academy reported on the Study of Constitution and By-Laws of thirty-five State Academies. Miss Margaret Patterson of Science Service gave a report on the history and affairs of the National Westinghouse Science Talent Search.

## BUSINESS MEMBERSHIP

Due to personal activities of Past-President Lloyd C. Bird, the Business Memberships of the Academy have been increased by six in addition to those mentioned last year. All of these but one have continued their membership giving a total at this time of twelve such memberships. The new members in this classification are as follows:

Reynolds Metal Company, Richmond, Virginia.

Norfolk and Western Railroad, Roanoke, Virginia.

Philip Morris, Company, Ltd., Richmond, Virginia.

Esso Standard Oil Company, Richmond, Virginia.

Virginia-Carolina Chemical Company, Richmond, Virginia.

C. D. Flowers School Equipment Company, Richmond, Virginia.

Gifts were also received from Morton G. Thalhimer, and Mrs. Alfred duPont, in addition to the annual gift of Mr. C. M. Goethe, of California, who for many years has contributed funds for the use of the Research Committee.

FOLEY F. SMITH, *Secretary*

FINANCIAL STATEMENT  
VIRGINIA ACADEMY OF SCIENCE  
CONSOLIDATED FUND BALANCE SHEET  
DECEMBER 31, 1954

EXHIBIT A

ASSETS

GENERAL FUND:

Cash in Bank (Exhibit "B") .....\$ 5,318.66

Investment (At Cost): Preferred Stocks  
(Market Value \$1,801.00) ..... 2,445.95

*Total General Fund* ..... \$ 7,764.61

RESEARCH FUND:

Cash in Bank (Exhibit "C") ..... \$ 850.88

Due from Trust Agent—Special Invest-  
ment Account (Temporary Investment) ... 2,000.00

*Total Research Fund* ..... 2,850.88

TRUST FUND PRINCIPAL ACCOUNT: (Note I)

Cash on Deposit (Exhibit "D") ..... \$ 25.96

Investments (At Cost): United States  
Savings Bonds, Series "F",  
"G" and "K" ..... \$ 7,337.00

Stock Securities (Market  
Value \$11,672.70) ..... 9,489.66 16,826.66

*Total Trust Fund Principal Account* ..... 16,852.62

TRUST FUND PRINCIPAL—INVESTMENT INCOME ACCOUNT:

Cash on Deposit (Exhibit "E") ..... \$ 385.81

*Total Trust Fund Principal—Investment  
Income Account* ..... 385.81

TRUST AGENCY SPECIAL ACCOUNT: (Note I)

Cash on Deposit (Exhibit "H") ..... \$ 22.94

Investments (At Cost): United States  
Savings Bonds, Series "J" ... \$ 1,584.00

Stock Securities (Market  
Value \$2,255.00) ..... 1,991.80 3,575.80

*Total Trust Fund Special Account* ..... 3,598.74



## TRUST FUND SPECIAL ACCOUNT—INVESTMENT INCOME ACCOUNT:

Cash on Deposit (Exhibit "I") .....	\$	66.00
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<i>Total Trust Fund Special Account—</i>		
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<i>Investment Income Account .....</i>		66.00
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		<u>\$31,518.66</u>
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## LIABILITIES AND FUND SURPLUS

## GENERAL FUND:

Advance payment on Dues .....	\$	1,549.00
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Less Virginia Journal Sub- scriptions .....	857.75	\$ 691.25
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Due to the Virginia Journal of Science .....	857.75	
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Fund Balance .....	6,215.61	
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<i>Total General Fund .....</i>		\$ 7,764.61
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## RESEARCH FUND:

Fund Balance .....	\$	2,850.88
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<i>Total Research Fund .....</i>		2,850.88
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## TRUST FUND PRINCIPAL ACCOUNT:

Fund Balance—January 1, 1954 .....	\$15,608.14	
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Add—Cost of stock transferred from Trust Fund Accumulated Income Account .....	1,790.85	
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	\$17,398.99	
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Less—Loss on sale of stock .....	546.37	
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Fund Balance—December 31, 1954 .....	\$16,852.62	
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<i>Total Trust Fund Principal Account.....</i>		16,852.62
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## TRUST FUND PRINCIPAL—INVESTMENT INCOME ACCOUNT:

Fund Balance—January 1, 1954 .....	\$	346.25
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Add—Excess of Current Year's income over income distribution (Exhibit "E") .....	39.56	
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Fund Balance—December 31, 1954 .....	\$	385.81
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<i>Total Trust Fund Principal—</i>		
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<i>Investment Income Account .....</i>		385.81
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## TRUST AGENCY SPECIAL ACCOUNT:

Due to Research Fund .....	\$ 2,000.00
Less excess of book value of stock rights sold over cash received .....	1.26 \$ 1,998.74
Due to James River Project .....	1,600.00

*Total Trust Fund Special Account* ..... 3,598.74

## TRUST FUND SPECIAL ACCOUNT—INVESTMENT INCOME ACCOUNT:

Due to Research Fund (dividends on stock investment) .....	\$ 66.00
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*Total Trust Fund Special Account—  
Investment Income Account* ..... 66.00

\$31,518.66

NOTE 1: Trust Fund Account figures were taken from Trust Agent's report, First and Merchants National Bank of Richmond, and exclusive of cash, were not verified in any manner.

GENERAL FUND  
STATEMENT OF CASH RECEIPTS AND DISBURSEMENTS  
FOR THE YEAR ENDED DECEMBER 31, 1954  
EXHIBIT "B"

BALANCE ON DEPOSIT—JANUARY 1, 1954 ..... \$ 2,717.26

## RECEIPTS:

## Revenue:

## Dues:

Regular Members .....	\$ 1,819.00
Contributing Members .....	285.00
Sustaining Members .....	170.00
Collegiate Members .....	66.00
Business Members .....	1,000.00
Delinquent Dues for Prior Years Collected .....	1,539.00 \$ 4,879.00

## Gifts, Grants and Bequests—Virginia

Junior Academy of Science ..... 210.00

## Non-Revenue:

Advance Payment of Dues ..... \$ 1,549.00

Collections for May 1954 Meeting:

Sales of Booth Space \$345.00

Registration Fees ..... 245.50

\$590.50

Meeting Expenses Paid 164.44      426.06

Dividends from Stock Investment 105.40

Miscellaneous ..... 4.00

James River Project—For Deposit  
in Special Account ..... 1,600.00      3,684.46

*Total Receipts* ..... 8,773.46

\$11,490.72

#### DISBURSEMENTS:

American Association for Advancement of

Science Meeting ..... \$ 488.86

Junior Academy of Science ..... 700.55

Miscellaneous and General Expenses

(Schedule "I") ..... 275.10

Postage and Express ..... 91.14

Printing ..... 187.36

Science Talent Search ..... 629.36

Stationery Supplies and Stenographic Service ..... 118.62

The Virginia Journal of Science ..... 2,011.07

Traveling Expenses ..... 10.00

Dr. E. C. L. Miller Award ..... 50.00

Major Catesby Jones Award ..... 10.00

James River Project—Deposit in Special

Trust Agency Account ..... 1,600.00

*Total Disbursements* ..... 6,172.06

BALANCE—DECEMBER 31, 1954 ..... \$ 5,318.66

#### CONSISTING OF:

Cash on Deposit First and Merchants National Bank of

Richmond—Checking Account ..... \$ 5,318.66

### RESEARCH FUND

#### STATEMENT OF CASH RECEIPTS AND DISBURSEMENTS

FOR THE YEAR ENDED DECEMBER 31, 1954

#### EXHIBIT "C"

BALANCE ON DEPOSIT—JANUARY 1, 1954 ..... \$ 214.86

#### RECEIPTS:

##### Revenue:

Income from Trust Investments ..... \$ 736.02

Gifts, Grants and Bequests ..... 450.00

*Total Receipts* ..... 1,186.02

\$ 1,400.88



## DISBURSEMENTS:

Grant-in-Aid Awards .....	\$ 550.00
<i>Total Disbursements</i> .....	550.00

BALANCE ON DEPOSIT—DECEMBER 31, 1954 (Exhibit "A") ..... \$ 850.88

## CONSISTING OF:

Cash on Deposit First and Merchants National Bank of Richmond—Checking Account .....	\$ 850.88
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TRUST FUND PRINCIPAL ACCOUNT—PRINCIPAL CASH ACCOUNT  
STATEMENT OF CASH RECEIPTS AND DISBURSEMENTS  
FOR THE YEAR ENDED DECEMBER 31, 1954  
EXHIBIT "D"

BALANCE—JANUARY 1, 1954 ..... \$ 440.85

## RECEIPTS:

Proceeds from United States Savings Bonds maturing in January 1954 .....	\$ 1,000.00
Proceeds from payment on principal of Real Estate First Deed of Trust Note .....	1,400.00
Proceeds from sale of 10 shares of Servel Incorporated Preferred Stock .....	538.98
<i>Total Receipts</i> .....	2,938.98
	<u>\$ 3,379.83</u>

## DISBURSEMENTS:

Purchase of United States Savings Bonds, Series "K" .....	\$ 2,000.00
Purchase of 15 shares of Owens-Illinois Glass Company Common Stock .....	1,353.87
<i>Total Disbursements</i> .....	3,353.87

BALANCE—DECEMBER 31, 1954 ..... \$ 25.96

## CONSISTING OF:

Cash on Deposit with Depository Bank of the Trust Agent, First and Merchants National Bank of Richmond .....	\$ 25.96
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TRUST FUND PRINCIPAL ACCOUNT—INVESTMENT INCOME  
CASH ACCOUNT STATEMENT OF CASH RECEIPTS AND DIS-  
BURSEMENTS FOR THE YEAR ENDED DECEMBER 31, 1954  
EXHIBIT "E"

BALANCE—JANUARY 1, 1954 ..... \$ 346.25

RECEIPTS:

Dividends on Stock Investment ..... \$ 504.76

Interest on United States Savings Bonds ..... 158.80

Interest on Real Estate First Deed of

Trust Note ..... 52.50

Transferred from Trust Fund Accumulated  
Income Account—Investment Income

Cash Account ..... 38.38

*Total Receipts* ..... 754.44

\$ 1,100.69

DISBURSEMENTS:

Remittance to Virginia Academy of Science

Research Fund ..... \$ 664.88

Agent's Commission for Year Ended

March 31, 1954 ..... 50.00

*Total Disbursements* ..... 714.88

BALANCE—DECEMBER 31, 1954 (Exhibit "A") ..... \$ 385.81

CONSISTING OF:

Cash on Deposit with Depository Bank of the

Trust Agent, First and Merchants National

Bank of Richmond ..... \$ 385.81

TRUST FUND ACCUMULATED INCOME ACCOUNT—PRINCIPAL  
CASH ACCOUNT STATEMENT OF CASH RECEIPTS AND DIS-  
BURSEMENTS FOR THE YEAR ENDED DECEMBER 31, 1954  
EXHIBIT "F"

BALANCE—JANUARY 1, 1954 ..... \$ (63)

RECEIPTS:

Transfer of cash to cover deficit occasioned by purchase  
of stock which had been transferred to the Trust

Agency Special Account ..... 63

BALANCE—DECEMBER 31, 1954 ..... \$ 0

TRUST FUND ACCUMULATED INCOME ACCOUNT—INVESTMENT  
INCOME CASH ACCOUNT STATEMENT OF CASH RECEIPTS  
AND DISBURSEMENTS FOR THE YEAR ENDED  
DECEMBER 31, 1954  
EXHIBIT "G"

BALANCE—JANUARY 1, 1954 .....	\$	32.76
RECEIPTS:		
Dividends on Stock Investments .....		76.76
		<hr/>
	\$	109.52
DISBURSEMENTS:		
Remittance to Virginia Academy of Science—		
Research Fund .....	\$	71.14
Transferred to the Trust Fund Principal		
Account—Investment Income Cash		
Account closing this account .....		38.38
		<hr/>
<i>Total Disbursements</i> .....		109.52
		<hr/>
BALANCE—DECEMBER 31, 1954 .....	\$	0
		<hr/>

TRUST AGENCY SPECIAL ACCOUNT—PRINCIPAL CASH ACCOUNT  
STATEMENT OF CASH RECEIPTS AND DISBURSEMENTS  
FOR THE YEAR ENDED DECEMBER 31, 1954  
EXHIBIT "H"

ACCOUNT OPENED JULY 20, 1954

RECEIPTS:

James River Project Funds .....	\$	1,600.00
Sale of Stock Rights .....		7.57

*Total Receipts* ..... \$ 1,607.57

DISBURSEMENTS:

Transferred to Trust Fund Accumulated		
Income Account to cover deficit occa-		
sioned by purchase of stock later trans-		
ferred to Trust Agency Special Account	\$	63
Purchase of United States Savings Bonds		
Series "J" .....		1,584.00

*Total Disbursements* ..... 1,584.63

BALANCE—DECEMBER 31, 1954 (Exhibit "A") ..... \$ 22.94



## CONSISTING OF:

Cash on Deposit with Depositary Bank of the Trust Agent, First and Merchants National Bank of Richmond .....	\$	22.94
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TRUST AGENCY SPECIAL ACCOUNT—INCOME CASH ACCOUNT  
STATEMENT OF CASH RECEIPTS AND DISBURSEMENTS  
FOR THE YEAR ENDED DECEMBER 31, 1954  
EXHIBIT "I"

ACCOUNT OPENED JULY 20, 1954

## RECEIPTS:

Dividends on Stock Investments .....	\$	66.00
DISBURSEMENTS .....		None

BALANCE—DECEMBER 31, 1954 (Exhibit "A") .....	\$	66.00
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## CONSISTING OF:

Cash on Deposit with Depositary Bank of the Trust Agent, First and Merchants National Bank of Richmond .....	\$	66.00
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GENERAL FUND  
SCHEDULE OF MISCELLANEOUS AND GENERAL EXPENSES  
FOR THE YEAR ENDED DECEMBER 31, 1954  
SCHEDULE "I"

Auditing and Tax Service .....	\$	200.00
Virginia Corporation Registration Fee .....		5.00
Insurance—Fidelity Bond .....		12.50
Post Office Box Rental .....		30.00
Flowers—Dr. E. C. L. Miller .....		27.60
	\$	275.10

## REPORT OF THE LONG RANGE PLANNING COMMITTEE

One scheduled meeting of the Long Range Planning Committee was held at Richmond on October 2. Several meetings of smaller groups of the committee were held during the year. The following projects were considered: 1) Science Education and Scientific Manpower; 2) The Virginia Science Talent Search; 3) Academy Participation in the 1957 Jamestown Exposition; 4) Salaried Employees of the Academy.

As a result of recommendations made by the Long Range Planning Committee the Council has:

1. Appointed a Special Study Committee on Science Education with Dr. James Cole as chairman. It is understood that this committee has met and will report to the council at this meeting.
2. Appointed a committee to consider requesting funds from the National Science Foundation or other appropriate organization to finance a study of the results of the Virginia Science Talent Search.
3. Appointed a committee to confer with the Jamestown Exposition Commission about the possibility of Academy participation in the Exposition. This may include making available a special exposition issue of The James River Monograph at a nominal price for all visitors, if agreeable with the commission.

The Long Range Planning Committee has appointed a sub-committee, with Dr. Allen Gwathmey as chairman, to study the practicality of salaried employees to aid in carrying out the business of the Academy. This committee will report the results of their study at some future date.

The chairman wishes to take this opportunity to thank the membership of the committee for their enthusiastic cooperation.

E. S. HARLOW, *Chairman*

## REPORT OF RESEARCH COMMITTEE

Grants.—During the past year, the following grants have been made:

R. S. Young—Paleontology in Northern Shenandoah Valley of Virginia, Virginia Division of Geology, Charlottesville, Virginia .....	\$200.00
R. S. Dunning—Purchase of ammeter. 242 Carolina Ave., Norfolk 2, Virginia .....	15.00
J. T. Wood—Publication of "Distribution of Poisonous Snakes in Virginia", University Station, Charlottesville, Virginia...	50.00
A. W. Jeffreys—Flicker Frequency of Visual Preception and the Alpha Index of the Electroencephalogram. Western State Hospital, Staunton, Virginia .....	478.00
C. C. Fisher—Study of Uranium Ores, Division of Geology, Charlottesville, Virginia .....	100.00

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\$843.00

<i>J. Shelton Horsley Research Award.</i> —The J. Shelton Horsley Award was given to Dr. A. Lutz, College of William and Mary, for his paper (with E. B. Reid) on "Clovene and B-Caryophyllene Alcohol." Honorable Mention was given to Dr. L. Weiss of the Department of Economics, University of Virginia, for his paper on "Sequential Procedures that Control the Individual Probabilities of Coming to the Various Decisions." .....	\$100.00
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*Financial Report.*—

Total income for Research from May 1954 until

May 1955 .....\$1,386.69

Expenditures:

Research Grants and J. Shelton Horsley Research Award... 943.00

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Balance.....\$443.69

CHALMERS L. GEMMILL



## REPORT OF FINANCE COMMITTEE

The Finance Committee met April 4, 1955. The report of the auditor was approved.

The budget that was proposed by the Committee is attached. This budget is based on the experience of the past, both as to income and expenditures.

It will be noted that provision has been made for the estimated expenses of the Junior Academy and Science Talent Search, and also the cost of the Virginia Journal of Science.

## BUDGET

## VIRGINIA ACADEMY OF SCIENCE

## ESTIMATED INCOME AND EXPENDITURES—1955-56

## ESTIMATED INCOME

*Dues*

Regular Members .....	623	@	\$3.00	\$1,869.00	
Contributing .....	57	@	5.00	285.00	
Sustaining .....	25	@	10.00	250.00	
Collegiate .....	29	@	2.00	58.00	
Business .....	7	@	100.00	700.00	
					\$3162.00

*Gifts*

The American Tobacco Co.	1	@	100.00	100.00
Mrs. duPont .....	1	@	100.00	100.00

*Exhibit Fees*

Harrisonburg Meeting 10 booths	@	30.00	300.00	\$300.00
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*Stock Dividends*

Received .....			53.00	\$ 53.00
				<hr/>
				\$3715.00

## ESTIMATED ADDITIONAL INCOME

*Accounts Receivable**Dues (Delinquent)*

Regular .....	107	@	\$3.00	\$321.00	
Collegiate .....	16	@	2.00	32.00	
					\$353.00

*Registration Fees*

Harrisonburg Meeting .....	400	@	0.50	\$200.00	\$200.00
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*Stock Dividends*

Expected .....				\$ 52.00	\$ 52.00
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Total .....					\$605.00
Total Expected Income .....					\$420.00

## ESTIMATED EXPENDITURES — 1955-56

AAAS Meeting .....	\$ 200.00
ECL Miller Award .....	50.00
Jr. Academy and Science Talent Search .....	1,375.00
Annual Meeting Expenses .....	200.00
Audit and Tax Services .....	225.00
Premium on Fidelity Bond .....	12.50
Stenographic Services .....	225.00
Postage .....	125.00
Subscriptions to Jour. for Life and Honorary Members .....	40.00
Printing .....	200.00
Addressograph Services .....	125.00
Contingencies .....	200.00
Virginia Journal of Science .....	2,050.00
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Total Expected Expenditures .....	\$5,027.50
Expected Income .....	\$4,320.00
Expected Deficit .....	\$ 747.50

LLOYD C. BIRD, *Chairman*

REPORT OF THE VIRGINIA JUNIOR ACADEMY OF  
SCIENCE COMMITTEE

## JUNIOR OFFICERS

Jack Chaffin, *President*Adrienne Nettles, *President-Elect*

## COMMITTEE MEETINGS

October 16, 1954 .....	Thomas Jefferson Inn . . . . .	Charlottesville
February 19, 1955 .....	Thomas Jefferson Inn . . . . .	Charlottesville
May 12, 1955 .....	Madison College . . . . .	Harrisonburg

The Virginia Junior Academy of Science, organized to promote and maintain interest in science among secondary school students, has had during 1954-55 an individual membership of 3221, representing 101 affiliated science clubs. Sixty-two more clubs are affiliated with Junior Academy through affiliation with Science Clubs of America. The clubs represent schools from all parts of the State.

The following activities have been carried out during the year:

Mimeographed letters concerning activities were mailed three times during the year to all public and private high schools in the State.

The JUNIOR SCIENCE BULLETIN was issued three times during the year and mailed to every science teacher in the State whose mailing address could be obtained. The publication of the BULLETIN was made possible by a contribution of \$200 by the American Tobacco Research Laboratory. The printing was done by the Newport News High School print shop under the direction of Miss Susie V. Floyd.

A traveling library of kodachrome slides showing science projects displayed at the 1953-54 meeting of VJAS was circulated among the clubs.

Grants were made, to assist in project work, from research funds made available to the Virginia Academy of Science by the American Association for the Advancement of Science.

Summer scholarships of \$200 each were again made available by the University of Virginia and the College of William and Mary as awards to two outstanding Teacher-Sponsors.

Five Junior Science Days were sponsored by five colleges in cooperation with the Junior Academy. Excellent scientific programs and tours were offered the student and teacher visitors to the colleges. A total of 251 student exhibits were on display at the Junior Science Days (an increase of 115 over the previous year); 65 individual and 8 club exhibits were qualified for entry at the May meeting of the Virginia Junior Academy of Science.

## ANNUAL MEETING

The annual meeting of the Junior Academy was held at Madison College on May 12 and 13. Sixty individual and eight club displays were exhibited.



Senior scientists advised students on their scientific careers, and discussed their projects with them. Selected students had senior scientists as "buddies" for a part of the day on May 13. (Virginia's Junior-Senior "Buddy Program" has received favorable comments nationally by such scientific organizations as the American Chemical Society and the Scientific Manpower Commission. The students, themselves, feel that it is a most valuable contribution of the Virginia Academy of Science, and are deeply grateful for the interest of members of the Academy in their scientific endeavors.)

A guest speaker, Dr. E. D. Crittenden, Director of Research, the Nitrogen Division of Allied Chemical and Dye Corporation, gave a very inspirational talk on the subject: THE UNFOLDING WORLD.

The following awards were made by the Virginia Junior Academy of Science:

E. C. L. MILLER AWARD, for club having the most outstanding program of activities,

Advanced Science Club, Mt. Vernon High School, Alexandria  
R. H. Horn, Sponsor

MAJOR CATESBY JONES AWARD, for most outstanding piece of research,  
Mathew Winston, Booker T. Washington High School, Norfolk

#### AWARDS FOR INDIVIDUAL EXHIBITS

First Place—Fred Barloga, Mt. Vernon High School, Alexandria  
Project—*Marine Model Testing Chamber*

Second Place—Bob Showalter, Broadway High School, Broadway  
Project—*Chick Embryology*

Third Place—William Conde, Huntington High School, Newport News  
Project—*Electronic Timing Circuits*

Honorable Mentions—Suzanne Wright, Lane High School, Charlottesville

Project—*Study of a Lake*

Joanna Hackman, Radford High School

Project—*A Nutritional Study of Algae*

#### AWARDS FOR CLUB EXHIBITS

First Place—Newport News High School, Newport News.  
Miss Susie V. Floyd, Sponsor  
Project—*Study of the Bee*

Second Place—Mt. Vernon Advanced Science Club, Alexandria.  
R. H. Horn, Sponsor

Third Place—Norview High School, Norfolk.  
Frank Kizer, Sponsor

Project—*Facets of Testing and Control Important to Man*

## HONORARY MEMBERSHIPS,

*American Association for the Advancement of Science*

Victor Werner Ludewig, Lane High School, Charlottesville

Ralph Daniel Reymond, Washington-Lee High School, Arlington

*Virginia Academy of Science*

Richard Leatherman, Wilson Memorial High School, Fishersville

David Lundquist, Newport News High School, Newport News

## TEACHER-SPONSOR SCHOLARSHIPS

University of Virginia Scholarship—Miss Samuella Crim, Broadway.

Alternate, Miss Lois Rynaldo, Hopewell

College of William and Mary Scholarship—R. H. Horn, Alexandria

Alternate, Mrs. Kate McDermott, Madison Heights

THELMA C. HEATWOLE, *Chairman*

## REPORT OF THE COMMITTEE ON THE VIRGINIA SCIENCE TALENT SEARCH

The Tenth Virginia Science Talent Search was conducted with the same purposes and procedures as in previous years. The search was made in cooperation with the National Science Talent Search as conducted by Science Clubs of America, Washington, D. C., for the Westinghouse Foundation.

This year (1954-55) there were one hundred and fifty completed entries from forty-one different Virginia high schools. From these forty-five finalists, including six that had been chosen honorable mention in the National Search, were invited, with part expenses paid, to attend the meeting at Madison College. Thirty-eight attended and were accompanied by thirteen teacher-sponsors.

Committee members and invited judges, operating in four panels, interviewed the finalists and selected a group of fourteen winners. The other finalists attending the meeting were given honorable mention.

### COMMITTEE MEMBERS

H. H. Garretson, <i>Chairman</i>	Thelma C. Heatwole
Edward E. Dyer	Alfred L. Wingo
C. M. Kincaid	Mary E. Kapp
Percy H. Warren	J. H. Johnson
James W. Cole	L. W. Jarman

### JUDGES

Frank C. Vilbrandt	James B. Newman
I. D. Wilson	R. C. Howard
Lowell V. Heisey	G. W. Kent
G. S. Mumford	W. Donald Clague

### WINNERS

\* *These students received National Honorable Mention.*

- Don Stowe Cromley, Mount Vernon High School, Alexandria
- \* Robert Scott Dunning, Norview High School, Norfolk
- \* Frederick John Gaiser, Washington-Lee High School, Arlington
- \* Michael David Garrick, Newport News High School, Newport News
- Edward Lee Gibbon, Thomas Jefferson High School, Richmond
- \* Joanna Hackman, Radford High School, Radford
- Richard Alexander Jesser, Waynesboro High School, Waynesboro
- Victor Werner Ludewig, Lane High School, Charlottesville
- Melvin Douglas Miller, Newport News High School, Newport News
- Robert Matthew Olton, Thomas Jefferson High School, Richmond
- \* Robert Milton Pearlstein, Washington-Lee High School, Arlington
- Ralph Daniel Reymond, Washington-Lee High School, Arlington



\* Margaret Gene Senter, Andrew Lewis High School, Salem  
Betty Sue Siler, Radford High School, Radford.

#### HONORABLE MENTION

Robert Earl Bailey, Washington-Lee High School, Arlington  
Fred Ross Barloga, Mount Vernon High School, Alexandria  
Curtis Marvin Brooks, Maury High School, Norfolk  
Winifred Catherine Firsh, Washington-Lee High School, Arlington  
Robert Peel Futrelle, Loudoun County High School, Leesburg  
James Allen Hall, Halifax County High School, South Boston  
Nelson Lee Hall, Lane High School, Charlottesville  
Carl Hennrich, Washington-Lee High School, Arlington  
James Richard Hobson, Washington-Lee High School, Arlington  
Jerry Randolph Holt, Pulaski High School, Pulaski  
William Gordon Hunter, Washington-Lee High School, Arlington  
Mary Beverly James, Thomas Jefferson High School, Richmond  
Lonnie Willard Knight, Mount Vernon High School, Alexandria  
Christopher Kounnas, Newport News High School, Newport News  
Richard Lee Leary, Cradock High School, Portsmouth  
William Frederick McGonegal, Norview High School, Norfolk  
Ronald Angus McKenney, Mount Vernon High School, Alexandria  
Luther Howard Martin, Washington-Lee High School, Arlington  
John Daniel Norwood, Norview High School, Norfolk  
Walter Fenton O'Brien, Jr., Jefferson Senior High School, Roanoke  
David Keith Richart, John Marshall High School, Richmond  
Clifford James Roberson, Jr., Jefferson Senior High School, Roanoke  
Arnold Gary Rubin, Woodrow Wilson High School, Portsmouth  
Frederick William Stevens, Mount Vernon High School, Alexandria  
William Edgar Trout, III, Thomas Jefferson High School, Richmond  
Matthew Maurice Winston, Booker T. Washington H. School, Norfolk

The names of these students were sent to the thirty-four Virginia Colleges and Universities which have cooperated with the Virginia Academy of Science in making scholarship funds available upon application.

The Chairman wishes to take this opportunity to express his gratitude: to Dr. Dyer and Mrs. Heatwole for their advice and assistance, to the faculty members of the University of Virginia who helped in grading the student essays, and to the Committee Members and Judges for their willing and ready service.

HAROLD H. GARRETSON, *Chairman*

## JAMES RIVER PROJECT

## FINANCIAL STATEMENT AS OF APRIL 30, 1955

Total copies distributed as of May 5, 1954 .....	530
Balance on deposit People's National Bank, Lexington, Va. as of May 5, 1954 .....	\$1,753.90
Complimentary copies distributed between May 5, 1954 and April 30, 1955 .....	1
Copies sold, payment received at \$6.00 between May 5, 1954 and April 30, 1955 (2) .....	\$12.00
Total copies distributed between May 5, 1954 and April 30, 1955 .....	3
Deposited in bank between May 5, 1954 and April 30, 1955 .....	\$12.00
Withdrawn for investment by Trust Dept. First and Merchants National Bank. (Authorized by Council) .....	\$1,600.00
Balance in People's National Bank after withdrawal of \$1,600.00 .....	\$153.90
Total balance in People's National Bank as of April 30, 1955 .....	\$165.90
Total to credit of James River Project as of April 30, 1955 .....	\$1,765.90
Total copies distributed May 11, 1950 to April 30, 1955 .....	533

MARCELLUS H. STOW, *Chairman*

## REPORT OF COMMITTEE ON CONSERVATION

There has remained a steady interest in resource use education matters in Virginia as exemplified by the members of the Resource Use Education Committee of the Virginia Academy of Science engaged in conservation education work.

Several of the Committee's members participated in the fall meeting of the Virginia Resource Use Education Council which met in September near Portsmouth, Virginia. Several members of the group have been assisting in the preparation of a resource use educational booklet to be published by interested conservation agencies within the State and to be distributed to the public schools in autumn.

The Academy, through its Committee, gave its endorsement to the eighth statewide conservation essay contest conducted by the Virginia Commission of Game and Inland Fisheries and the Virginia Division of the Izaak Walton League of America. As a result of this annual affair it is believed that close to 100,000 Virginia school pupils have been taught the fundamentals of conservation.

Members of the Committee have been asked to assist in the preparation and publication of the Academy's new proposed book on the Great Dismal Swamp, and at least one member of the Committee has been asked to prepare a full chapter in this publication.

No Committee meetings were held during the year although one was contemplated, but because of the difficulty of getting together in one location the meeting was dispensed with and in its place a questionnaire was circulated asking for suggestions and recommendations of members.

In general it can be said that the members favor a continuation of the Committee but that its objectives be more clearly defined by the Academy. There appears to be a growing feeling that the Committee's name should be changed and that it function as a Conservation Committee of the Academy.

J. J. SHOMON, *Chairman*

#### COMMITTEE ON VIRGINIA FLORA

Work relative to the flora of Virginia progresses, though slowly. The state herbarium at the Virginia Polytechnic Institute is progressing. Several hundred specimens from different parts of the State have recently been donated to the herbarium by Mr. F. W. Hunnewell through the Gray Herbarium and Mr. G. C. Mason through the Mariners Museum. Such contributions enhance the value of the herbarium in studies of the State flora and economic botany. Specific attention is being given to such major groups as the legumes, grasses, and the aquatic plants. The manuscripts of these are well along.

Dr. Patterson continues his valuable studies relative to the identification, distribution, and ecology of the mosses.

Members of the committee have given lectures to lay groups relative to the identification and conservation of our Native plants. These lectures are illustrated by slides, films, specimens, or some combination of these.

A supply of Professor Merriman's book, *Flora of Richmond and Vicinity*, is still on hand. These have sold slowly in recent years.

A. B. MASSEY, *Chairman*



## REPORT OF THE VIRGINIA INSTITUTE FOR SCIENTIFIC RESEARCH

The most significant event of the past year was the appointment of Dr. Fontaine Catesby Armistead as the first Director of the Institute charged with the overall responsibility for its operation. The Institute is greatly indebted to Dr. Robert Kean and Dr. Henry Leidheiser, who largely carried the administrative duties during the first five years of existence of the Institute.

Dr. Armistead is a physicist by training, a native of Richmond, a graduate of St. Christopher's School and of the University of Virginia where he carried out both his graduate and undergraduate studies. During the war, he conducted research on the separation of uranium isotopes with the aid of the ultracentrifuge; and for the past few years, he has been associated with the Massachusetts Institute of Technology.

The research activities during the past year largely include two major fields — surface chemistry and the determination of the sizes, shapes, and weights of large molecules. Dr. Leidheiser is immediately in charge of the studies in surface chemistry, and during the past year important discoveries have been made in the field of corrosion and in obtaining a better understanding of the photographic process in silver chloride crystals. The studies on molecular weights are under the directorship of Dr. Carl Likes, and during the past year, he has begun an investigation of the protein molecules found in tobacco. Under the direction of Mr. von Gemingen, the electron microscope is being increasingly used to assist other laboratories in this region. The business of supplying special single crystals to other laboratories continues, and a new project is being started for the development of better methods of growing certain crystals for an important commercial use.

At the present time, there are six major projects being undertaken at the Institute. There are twelve regular employees and six part-time employees. The research being done at the present time involves about \$90,000 a year.

The Institute is pleased that Dr. Leidheiser has been invited to present a paper before Busen-Gesellschaft (equivalent to the Electrochemical Society) in Germany in May of this year. The subject of the meeting is "Processes at Metal Electrodes." He will visit a large number of laboratories in Germany, France, and England, and it is believed this trip should be of great value both to Dr. Leidheiser and to the Institute.

ALLAN T. GWATHMEY, *President*

## REPORT OF THE SPECIAL STUDY COMMITTEE ON SCIENCE EDUCATION

The Council of the Virginia Academy of Science on March 13, 1955, established a large committee, on an experimental basis, to bring together a breadth of viewpoints for a discussion of the problems of science education in Virginia and to define, if possible, any problems within the responsibility of the Virginia Academy of Science. The committee was requested to report to the Council during the Annual Meeting of the Academy at Madison College on May 12, 1955. The President of the Academy, with the advice of various members, appointed 25 members to the committee, representing industry, business, secondary schools, colleges, and universities, and the State Board of Education. A list of the members is appended.

At the outset the chairman requested each member to submit any available factual information pertaining to science education in Virginia, to recommend procedures for the Committee and to suggest areas where the Academy might take action. The response was very gratifying with a wide spectrum of thoughts being submitted. It was possible to hold only one meeting of the Committee during the short time available. On April 23, 1955, twenty members had a lively discussion of some of the issues in the President's Conference Room of the Medical College of Virginia. Each of the members who was unable to attend made comments on the Committee's responsibility through letters to the chairman. This report is an attempt to present some of the problems in their broader aspects. It incorporates sentiments expressed by members of the Committee and includes five recommendations for action by the Virginia Academy of Science.

The Special Study Committee recognizes that it is dealing with a very perplexing aspect of our current civilization. There have been statements from various parts of the scientific community of the Nation indicating there may be a crisis approaching in science education. Concern has been expressed in many quarters that a continuing expansion in the number of high quality scientists and engineers is necessary if the American way of life is to continue. In some statements, the short supply and the apparent decline in the relative numbers of graduates in these fields has been attributed to conditions associated with the schools, colleges, and universities. Expressing the various viewpoints are many elegant quotations which stress the need for doing something about education in the science. It is a much more difficult task, however, to assemble statistics and other facts which point-up the specific needs and state the problems in Virginia in ways for effective presentation to those who make and administer the policies.

There are some publications based on long-term studies which have implications of concern for science teaching everywhere. The U. S. Office of Education has information on the number of boys and girls at various levels in our educational system. Such statistics show the rate of increase in the school population and this can be related to some of the basic needs of the future. The National Science Foundation in its Fourth An-



nual Report (1954) stated that there is a shortage of qualified science teachers and indicated that this situation may get worse. The National Educational Association estimated the need for *new* high school science teachers over the next decade as increasing from 7,700 per year in 1954-55 to over 10,000 per year in 1965-66. The available information on college graduates qualified and willing to teach high school science subjects shows that the current needs are not being met and that there may be an increasing gap between supply and demand.

One of the most definitive sources of information on the potential supply of talented people is the recent publication "America's Resources of Specialized Talent" by Dael Wolfle, who was director of the Commission on Human Resources until his recent appointment as Executive Secretary of the American Association for Advancement of Science. This publication, which has become known as the Wolfle Report, contains much factual information and it is finding increasing use by the professional and scientific organizations, which have expressed concern over the short supply of high quality scientists and engineers, and which have initiated programs directed toward increasing the supply. Perhaps of greater importance is that many of these groups also have emphasized the need for an increasing awareness of the role that science is now playing in our everyday life and of the critical role persons with understanding of our modern technology will play in the event of a National emergency.

The Academy must now decide whether it wishes to take extraordinary steps to help define and to assist in solving some of the current problems. Some new activities suggested are in keeping with one of the major objectives of the Academy—to arouse interest in and appreciation of science among the people of the State. An intelligent and well organized information source can help show the people of Virginia that the occupations connected with the training of our young people are of major importance in our way of life. Many close to the problems of education have expressed the need for more awareness on the part of the general public of the problems associated with teaching and for a wider recognition that our most precious possession is the talented youth. This Special Study Committee feels that the Academy can intensify its endeavors directed toward increasing public awareness of educational problems by establishing a permanent committee on science education.

It is recommended that this committee be small enough to work effectively, but it should have representation from industry, secondary education, higher education, and the State government. It should be not only a fact-finding group for gathering statistical information which will be useful in supporting recommendations for policies at all levels in our school systems, but also a center for accumulating opinions of a **more subjective** nature, the importance of which will be related to the number of such opinions. Moreover, if the Virginia Academy of Science is going to have an effect on actions which will improve any existing situations then the information must be disseminated in ways to impress those who support, influence, and administer our educational systems.



Several factors have been cited as motivations away from science teaching as a career. Some members of the scientific community believe that the salaries of science teachers, especially in the secondary schools, are too low to attract the needed number of qualified people into science teaching and away from the higher salaries in other occupations for which these people may also be qualified. This aspect is fairly easy to document from statistics gathered by professional organizations like the American Chemical Society and the American Society of Civil Engineers. Others go beyond monetary considerations and feel that a reasonable definition of a science teacher, perhaps incorporated in the requirements for certification for the teaching of science, will attract more qualified people because of the relationship between high specifications for a position and the prestige and professional standing of the position. Some feel that those teaching science should be primarily science teachers and not be required to use their energies in extra-time activities, which are not closely related to science teaching. Other factors of a more intangible nature have been mentioned but they cannot be conveniently incorporated in this report. A permanent committee can assemble information that will help define the tangibles as well as the subtle things which appear to make science teaching less attractive and which, if brought to the attention of those concerned, might be fairly easily remedied.

As a second item the Special Study Committee recommends that a supervisory position be established to represent science education at the State level. This person might supervise activities related to the certification of science teachers and the maintenance of facilities, and initiate other activities which are appropriate to insure that the Commonwealth of Virginia provides science education at all levels which is adequate and at least equivalent to that of every other state. It should be emphasized that if this recommendation is made at the State government level that a detailed brief should accompany the recommendation which points out any unusual situations in Virginia and demonstrates that there is a need for the position. If the Academy determines that its responsibility is to pursue this recommendation, it is suggested that a special committee be established specifically for the purpose of assembling information and preparing the proposal.

In another area it is recommended that a committee be established to serve as a coordinating center for the activities of various organizations in Virginia which are now working to promote more interest in science and the building up of the scientific manpower resources. The main function of this committee would be to encourage interested organizations to participate, and to serve as a clearing house of information so as to avoid duplication and to make the endeavors as effective as possible. This committee could help with the arranging of schedules of science teachers conferences, science open house days, special events, *etc.*, so that wider participation can be achieved. It should be emphasized that there is no intention to usurp any of the functions of other organizations which are now active but

only to try to keep each informed of what the other is doing and to provide the most effective service to those doing the actual teaching.

Another committee is recommended to promote a mutual and sympathetic approach on the parts of teachers of scientific subjects and of those more closely connected with professional education. The criticism of the methods of some groups has caused some persons to feel that an exchange of information will be very helpful so that areas of agreement can be determined and the energies of those interested and active can be applied most effectively. For example, there seems to be interest in increasing the in-service training possibilities for those doing the classroom teaching. Also there may be ways in which our scientists can be used during the school year as consultants on teaching scientific subjects in the secondary schools. The apparent need is a medium for bringing the interested groups together.

The Special Study Committee recognizes the value of a large group to serve in an advisory and review capacity. It recommends that a large advisory panel on science education be established on a permanent basis, along the lines of this Special Study Committee, and that it comprise representatives from business, industry, secondary schools, colleges and universities, and the State government. This panel might first promote a statewide conference at which all interested in science education may be heard. It should meet occasionally to hear reports from any of the above committees and from any additional sub-committees it might care to establish. This panel should make recommendations directly to the Academy of Science and also encourage its members to participate in outside activities, such as School Boards and Parent-Teachers Associations. It could offer its services at the State government level and give advice if so requested. While it was recognized that a large group would have cumbersome aspects and that its success might not be readily measured in terms of concrete accomplishments, nevertheless it was felt that a group with broad representation and wide interests could make many indirect contributions.

This Special Study Committee of the Virginia Academy of Science was fortunate in having access to other studies made in Virginia under the auspices of the Virginia Academy of Science. Particularly valuable are the Reports of the Committee on Resource-Use Education, the Committee on Science Teaching in Secondary Schools in Virginia, and the Survey of the Science Facilities in the Secondary Schools in Virginia. These committees and others have focused attention on special problem areas and the reports have been included in the proceedings of the Academy. This Special Study Committee would like to point out that the Academy as an organization should also determine if follow-up action is needed on these committee reports.

In summary, the recommendations of this Special Study Committee consist mostly of proposals for the establishment of new committees with some suggested areas of action. These are:

1. A permanent, working committee on science education, representing industry, secondary education, higher education, and the State government. Its function should be mainly fact finding, keeping abreast

of developments in science education and disseminating information where appropriate.

2. A special committee to prepare a brief for presentation at the State level in support of the recommendation that a supervisor of science be established in the State Board of Education.
3. A committee to serve as a coordination center for the activities of various organizations which are trying to promote more interest in science and engineering.
4. A committee representing both the subject matter and the methodological approach to science teaching, to develop new activities of mutual benefit.
5. A fairly large advisory panel, representing all interested areas, to review and evaluate reports of the other committees and to give advice at any level when requested.

Members of the Special Study Committee on Science Education are: Dr. Lynn D. F. Abbott, Jr., Mr. Lloyd C. Bird, Dr. John B. Chase, Jr., Dr. Byron N. Cooper, Mr. Edwin Cox, Miss Samuella Crim, Dr. E. D. Crittenden, Dr. R. W. Engel, Miss Susie V. Floyd, Dr. William T. Ham, Jr., Mr. Edward S. Harlow, Mrs. Thelma C. Heatwole, Dr. Ladley Husted, Dr. George W. Jeffers, Mr. Franklin D. Kizer, Major James A. McDonough, Dr. Sidney S. Negus, Mr. A. B. Niemeyer, Jr., Dr. Alexander Sadle, Mr. H. Felix Sanders, Mr. Foley Smith, Dr. William E. Trout, Jr., Dr. John C. Wells, Mr. Alfred L. Wingo, and Dr. James W. Cole, Jr.

THELMA C. HEATWOLE, LADLEY HUSTED,  
AND JAMES W. COLE, JR., *Chairman, Protem*



## REPORT OF THE VIRGINIA JOURNAL OF SCIENCE

In 1949, there was only a hope and a prayer for re-establishing the Virginia Journal of Science. Many members had expressed a desire for a journal through letters and otherwise, but, in general, it was felt that there would not be sufficient demand for a journal, there would not be sufficient papers for a journal, and there would not be sufficient money on which to operate a journal. Your President at that time was determined to give the journal a try and to see if it could not be a literary as well as a financial success.

The cost of printing the Proceedings under the arrangement existing at that time amounted nearly to what it would cost to publish a journal. Under special arrangements, the President was able to make with the *Radford News-Journal*, four issues of the journal could be printed for almost the same cost as the Proceedings.

At a meeting on June 19, 1949, I was elected Editor-in-Chief and Dr. Hobbs, Technical Editor with the understanding that for the first year we would be supplied with a sufficient amount of money to publish the journal and to give the journal a sufficient reserve fund. Three sets of letters were then mailed to the membership urging their support in re-establishing the journal. One of these letters was mailed under the auspices of Dean Ivey F. Lewis of the University of Virginia. The other two letters were sent out later by the President and the newly elected Editor. Upon this request, 328 members contributed \$2.00 each, 49 members increased their memberships to that of contributing members, and 18 became sustaining members. The Council of the Academy then voted to allot \$2.00 from each membership fee to the journal. This was the beginning of the Virginia Journal of Science. Since that time, five Proceedings and 22 issues of the Journal have been published. They total 2,017 pages and according to the indexes, 120 articles.

The Journal has served as a medium for carrying the news and activities of the scientists in Virginia. It has held the membership closer together, and it has given the membership a continuity of progress in addition to their Annual Meetings. Prior to the Journal, there was no accurate record of membership. Since then, the membership has increased by thirty per cent according to figures of paid-up members to whom the Journal is sent. The financial success of the Journal is best stated by presenting to you the current balance of its regular checking and savings accounts. These amounts are \$2,504.05 and \$2,593.61 respectively making a total of \$5,097.66.

The Journal has now successfully operated for over five years. Its financial success would not have been possible without the continued support of the Virginia Polytechnic Institute. The future of the Journal looks rosy. More subscriptions are coming in.

I have enjoyed my work with the Journal but feel that others in the Academy should now try their hands at furthering its success. I have tendered my resignation, and this will be my last time to address you as Editor-in-Chief of the Journal. The Editorial Staff and the Academy as

a whole have given me great encouragement, valuable assistance, and continued backing. These things alone have made all my effort on behalf of the Journal worthwhile. I wish the new officers of the Journal the greatest success in making the Journal a medium for holding together the scientists of Virginia, a means of publishing the scientific literature that will be produced in Virginia in the next few years, and as an instrument for promoting the strongest, the largest, and the most successful state academy in the nation.

BOYD HARSHBARGER, *Editor-in-Chief*

FINANCIAL STATEMENT  
VIRGINIA JOURNAL OF SCIENCE  
VIRGINIA POLYTECHNIC INSTITUTE  
STUDENT ACTIVITIES OFFICE  
OPERATION STATEMENT FOR THE FISCAL YEAR  
VIRGINIA JOURNAL OF SCIENCE  
May 5, 1954, to May 10, 1955

#### RECEIPTS

Academy Subsidy	
Regular members 974 at \$2.00 .....	\$ 1,948.00
Student members 50 at \$1.25 .....	62.50
Advertising .....	400.30
Subscriptions .....	335.98
Extra pages .....	50.00
Miscellaneous .....	38.00
	<hr/>
TOTAL OF ALL RECEIPTS .....	\$ 2,834.78

#### EXPENDITURES

Reprints .....	\$ 116.00
Printing .....	2,011.81
Postage .....	113.05
Engraving .....	86.02
Office supplies .....	62.00
Index .....	31.50
Miscellaneous .....	154.60
Transfer to savings .....	1,000.00
	<hr/>
TOTAL OF ALL EXPENDITURES .....	\$ 3,574.98
NET AMOUNT .....	<hr/> -740.20 <hr/>

## STATEMENT OF CASH ACCOUNT

Balance of cash at beginning of year .....	\$ 3,244.25
Total receipts for year .....	2,834.78
Total cash on hand during year .....	6,079.03
Total expenditures for year .....	3,574.98

Balance of cash at end of year (checking account) .....	2,504.05
Balance of cash at end of year (savings account) .....	2,593.61

TOTAL .....\$ 5,097.66

Audited by: Joe W. Guthridge

Date: May 10, 1955

## VIRGINIA JOURNAL OF SCIENCE

## STATEMENT OF ACCOUNTS RECEIVABLE

MAY 10, 1955

Dombrower Advertising Agency .....	\$ 24.90	
April 1955 issue .....		
Cardinal Products .....	29.40	
April 1955 issue .....		
American Tobacco Company .....	29.40	
April 1955 issue .....		
Marchant Calculator .....		
January 1955 issue .....	\$ 9.80	
April 1955 issue .....	9.80	19.60

TOTAL .....\$103.30

Audited by: Joe W. Guthridge

Date: May 10, 1955



## REPORT OF JAMESTOWN EXPOSITION SURVEY COMMITTEE

By letter of November 3, 1954, President Foster appointed William G. Guy, Horton H. Hobbs, Jr., and the undersigned as a "committee to meet with the Jamestown Celebration Committee and explore the avenues of cooperation between this group and the Virginia Academy of Science." The Committee was instructed to present a preliminary report to the Council of the Academy at its May meeting.

On January 28, 1955, the Chairman and Dr. Hobbs discussed the matter at some length. Four possible aspects of cooperation with the Jamestown Celebration Committee were considered and are noted herewith.

1. Put attractive jacket on copies of the James River Monograph and sell them at the Exposition for \$2.50-\$3.00.

2. Issue a special Jamestown Celebration number of the Virginia Journal of Science. This would not be in the regular Journal series and would not involve change in normal format or content of the regular issues of the Journal. It would be a specific and special issue featuring topics in keeping with the spirit of the Celebration. It might contain special advertising. It would be for sale during the year of the Celebration.

3. Development of appropriate exhibits in conjunction with other exhibits devised by the Jamestown Committee. These might be divided into two groups: one by the Senior Academy, possibly depicting the development of science in Virginia; the other by the Junior Academy, possibly depicting the development of science education in the secondary schools of Virginia.

4. Possibility of holding a special Academy meeting during the Celebration year or of holding the regular annual meeting in Williamsburg. (It was decided that the former would be impractical and it was learned later that plans for the 1957 meeting of the Academy were already being developed. Hence this topic was discarded without further consideration.)

During the morning of March 12, Messrs. Hobbs and Stow met with Dr. Guy at Williamsburg and the four points described above were discussed. No new phases of cooperation were developed and it was agreed to present the first three for tentative consideration by the Jamestown Celebration Committee.

At three o'clock that afternoon the Academy committee met with Mr. Parke Rouse, Jr., Executive Director of the Virginia 350th Anniversary Commission. Mr. Rouse was most enthusiastic about the possibility of participation by the Academy in the Celebration and about the three suggested means of effecting this participation.

The Academy Committee, obviously, was not authorized to make final commitments concerning Academy participation. Hence no specific details were developed.

Results of our conference are best expressed by quoting part of a letter written to the undersigned by Mr. Rouse under date of April 11, 1955.

"I gave our Commission a resume of our brief discussion when it met

here last Wednesday, and I want to report that considerable interest and enthusiasm was shown. We hope you will be able to go through with all your plans, and we'll be glad to do anything we can to help.

"Please assure your colleagues of our warm interest and keep us informed as your program develops."

MARCELLUS H. STOW, *Chairman*

## REPORT OF THE MEMBERSHIP COMMITTEE

As of December 31, 1954, the membership of the Academy was made up as follows:

Regular members .....	743
Business members .....	7
Contributing members .....	57
Sustaining members .....	25
Life or honorary members .....	14
Patrons .....	2
Student Members .....	33
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Total.....	881

All members in arrears in dues for more than one year had been dropped from membership as of January 1, 1955.

For the calendar year 1954 new members were obtained as follows:

Regular members .....	79
Student members .....	10
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Total.....	89

Losses for the calendar year 1954:

Regular members .....	84
Student members .....	15
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Total.....	99

The membership committee would like to report the following progress for the year 1955:

New Members:

Regular members .....	18
Student members .....	10
Business members .....	6
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Total.....	34



## MINUTES OF THE SECTION OF AGRICULTURAL SCIENCE [1]

RODNEY C. BERRY, Richmond, *Chairman*

R. W. ENGEL, Blacksburg, *Vice-Chairman*

P. M. REAVES, Blacksburg, *Secretary*

WESLEY P. JUDKINS, Blacksburg, *Section Editor*

FRIDAY, MAY 13, 1955—9:00 A. M.—ROOM 28, WILSON HALL

### 1. FORAGE-GRAIN SUBSTITUTION RATES IN MILK PRODUCTION.

Carl W. Allen; *Virginia Polytechnic Institute.*

The importance of an accurate determination of the rates of substitution between grain and forage in producing milk has been determined. The present study includes the introduction of an expression of the dependent variable (Y) which affected the solution in two ways: (a) the linear effect, and (b) the quadratic effect. The estimates of the dependent variable used to obtain the eleven additional "independent" variates are based on an earlier regression analysis. The purpose for making these added variates related to Y was to permit greater flexibility in the slopes of the iso-product contours.

Agricultural production is characterized by production processes in which factor substitution rates are dependent on the level of output. Some examples being (1) phosphorus and nitrogen in crop production, (2) grain and forage in meat production, (3) carbohydrates and protein in meat production, and (4) labor and capital in most production processes. This special method merits consideration in deriving such production functions.

### 2. SOIL FACTORS AFFECTING THE AVAILABILITY OF MANGANESE FOR PEANUTS.

C. I. Rich; *Virginia Agricultural Experiment Station.*

The influence of several soil factors on the manganese content of peanut leaves was studied. Soil factors studied were manganese content, pH, percentage organic matter, oxidation-reduction potential, exchangeable hydrogen, magnesium, calcium, potassium, and sodium. In 1951, samples from 28 fields showed that the following surface soil factors were related to the content of plant manganese as indicated by the analysis of variance: pH, exchangeable calcium and manganese, and easily reduced manganese.

The 1952 study with 101 fields showed that pH accounted for 28% of the variation of plant manganese. However, a consideration of five soil factors (pH, easily reduced manganese and exchangeable manganese, calcium, and magnesium) accounted for 62% of the variation. Low pH, calcium, and magnesium, and high soil manganese favored a high manga-

nese uptake. The exchangeable, easily reduced, and water soluble manganese tests were influenced markedly by the moisture and oxygen concentration in the soil.

### 3. CROP RESPONSE TO VARIOUS ROTATIONS IN THE PEANUT PRODUCING AREA OF VIRGINIA.

D. L. Hallock and L. I. Miller; *Virginia Agricultural Experiment Station, Holland.*

Yields of peanuts grown in three year rotations were significantly higher than those grown alternately with corn, which, in turn, were also higher than for peanuts grown every year on the same soil. Highest production of peanuts was obtained when cotton was included in rotation with peanuts and corn, an effect which may have been caused by (1) additional nitrogen and potash applied to cotton, (2) insecticide treatments applied for control of boll weevil, or (3) the immunity of cotton to common peanut diseases. The average yields of peanuts or corn were not influenced appreciably by cover crops of crimson clover or rye. Soybeans interplanted with corn did not depress corn yields significantly. A three year rotation which included only two years of harvested crops proved uneconomical. The tests were conducted on a soil with relatively high fertility. More response to rotations might have been obtained with less fertile soils.

### 4. SEED INJURY IN TREATED SEED WHEAT.

James W. Midyette, Jr.; *Virginia Department of Agriculture.*

In the fall of 1954 numerous lots of seed wheat, which had been tested by the Virginia Department of Agriculture in July and August, showed typical mercury injury when retested 4 to 6 weeks later. The injury decreased germination by 15 to 20 percent.

All lots of seed in question had been treated according to recommended rates and methods of application. The seed were not confined to one processor. The seed had been stored under hot and dry conditions and had a very low moisture content. A crack or opening existed in the pericarp over the embryo of some seeds and correlated very closely with the percentage of seedlings which showed mercury injury.

It was concluded that the high temperatures during storage caused the mercury compound to become volatile and to enter the openings in the pericarp, which caused injury to the tissues of the embryo.

### 5. PRELIMINARY OBSERVATIONS ON THE VALUE OF A LOW CALCIUM-HIGH PHOSPHORUS DIET FOR THE PREVENTION OF MILK FEVER IN DAIRY COWS.

W. A. Hardison, G. A. Miller, R. A. Sandy and G. C. Graf;  
*Virginia Agricultural Experiment Station.*

Milk fever is a metabolic disorder which is apparently caused by a sudden shortage of calcium in the cow's system resulting from the large

amount of calcium that is secreted in the milk following the birth of the calf. Work at the California Station indicates that a practical method of preventing this condition is the feeding of a ration with a Ca:P ration of approximately 1:4 for about one month prior to calving.

Ten animals with histories of previous attacks of milk fever have been fed a ration consisting of equal parts of a grain mixture (containing shelled corn, wheat bran, and a phosphorus supplement) and oat hay. Blood samples for calcium and phosphorus analysis were taken. None of these animals developed clinical symptoms of milk fever at calving and the blood levels of Ca and P of all the animals were within the normal range.

6. CROP RESPONSE TO ROCK PHOSPHATE ON VIRGINIA SOILS: PROGRESS REPORT.

W. W. Moschler; *Virginia Agricultural Experiment Station.*

Variable crop response is being obtained from the direct application of raw rock phosphate. Certain plants, particularly legumes, are more responsive than grasses, and certain soil conditions, especially pH, are critical factors governing efficiency.

Combined applications of the slowly soluble raw rock and a quickly soluble phosphate such as superphosphate offer the best promise encountered to date.

7. SULFUR CONTENT OF THE PRECIPITATION IN VIRGINIA.

J. A. Lutz, Jr.; *Virginia Agricultural Experiment Station.*

The continued use of high analysis sulfur-free fertilizers may result in crop injury caused by an inadequate supply of sulfur unless plants can obtain proper amounts from the precipitation and the atmosphere. Sulfur is essential for plant growth and is ordinarily used in amounts similar to phosphorus.

The amount of sulfur brought down per year in the precipitation has varied from 7 to 30 pounds per acre per year with the higher amounts near centers of industrial activity and the lower readings somewhat removed from industrial areas. More sulfur was brought down during the winter months than during the summer when less fuel containing sulfur was consumed.

Evidence thus far indicates that the amount of sulfur brought down in the precipitation is inadequate for normal plant growth. However, field experiments with crops in areas believed to be low in sulfur have failed to show any response to sulfur.

8. PROGRESS REPORT ON THE USE OF V-C 13 FOR THE CONTROL OF NEMATODES INFESTING TURF GRASSES.

M. A. Manzelli; *Research Department, Virginia-Carolina Chemical Corporation, Richmond.*

Field testing of V-C 13, a 75% emulsifiable concentrate of 0-2, 4-



dichlorophenyl 0, 0-diethyl phosphorothioate, has shown it to be effective in the control of nematodes infesting turf grasses. Good control was obtained with 125, 250, and 500 pounds of toxicant per acre.

The grasses treated were St. Augustine, annual rye, colonial bent, native Bermuda, and improved strains of Bermuda as Gene Tift and Everglades No. 1. The nematode genera involved were: *Aphenchoides*, *Dorylaimus*, *Hoplolaimus*, *Paratylenchus*, *Pratylenchus*, *Rotylenchus*, *Trichodorus*, and *Tylenchorhynchus*.

At the two highest application rates, a slight temporary injury to the grass blade tips was noted. Grasses became re-established in the treated plots, whereas the untreated check plots remained unchanged. The root systems in the former plots were vigorous and extensive, whereas in the latter plots they were short and weak. The life length of the achieved control is not yet known, but to date it is longer than nine months.

#### 9. APPLICATION OF SOIL SURVEY TO CERTAIN LAND USE PROBLEMS IN FAIRFAX COUNTY, VIRGINIA.

H. C. Porter and Soil Survey Party.

Fairfax County contains many different soils and land use problems, and has a rapidly increasing population of about 156,000. Economists predict a population of 320,000 by 1980. A Planning Commission has been hired by the county to make a Master Plan for the orderly adjustment of the population to the land.

A generalized soils map was made of the county in 1915, and information from it has been very extensively used in formulating the Master Plan. However, most agencies in the county felt that a more detailed survey was needed to help carry out the Master Plan, and in July, 1953, the county gave \$37,000 to help make such a survey. This survey will be finished early in 1956. New methods of applying soil survey information to the many needs of the county are illustrated by slides, maps, and soil monoliths.

#### 10. THE USE OF SEX HORMONES FOR FATTENING LAMBS.

W. S. Wilkinson; *Virginia Polytechnic Institute*.

The use of sex hormones in ruminants may be the most effective development to date for increasing meat production with greater profit to the producer.

Diethylstilbestrol implanted in feed-lot lambs increases growth rate and feed efficiency but decreases carcass quality and dressing percentage. Occasionally it causes physiological abnormalities. The Federal Pure Food and Drug Administration has not approved its use in lambs.

An implant containing estradiol plus progesterone (trade name of Synovex) has been advertised as giving an increased rate of gain similar to diethylstilbestrol but causing no abnormalities or harmful carcass effects. This pellet has been approved for use in lambs by the Food and Drug Administration.

These hormones are not retained in the lamb carcass to any extent, and the meat is completely safe for human consumption.

Testosterone increases rate of gain and feed efficiency — an effect similar to the estrogens but not so great.

11. OBSERVATIONS ON THE PHYSIOLOGY OF THE BOVINE DIGESTIVE TRACT WITH SPECIAL REFERENCE TO ORGAN ACTIVITY.

W. E. C. Moore and K. W. King; *Virginia Agricultural Experiment Station*.

The ingesta from each digestive organ of nine slaughtered cattle has been analyzed in an attempt to clarify the specific digestive function of each organ. Total weight, dry matter, pH, cellulolytic activity, ammonia, soluble nitrogen, total carbohydrate, polysaccharide, amino acid, and volatile fatty acid analyses of each ingesta sample were performed.

Three relatively obscure functions appear to be clarified. One is the rapid and nearly quantitative destruction of starch in the omasum, indicated by disappearance of polysaccharide from the ingesta in this organ. Another is rapid absorption of volatile fatty acids in the omasum. The third is rapid bacterial fermentation in the lower small intestine, cecum, and colon which is reflected in the accumulation of ammonia, polysaccharide, and volatile fatty acids in the ingesta of the lower gut.

12. IN VITRO ESTIMATION OF THE CELLULOLYTIC ACTIVITY OF RUMEN INGESTA.

S. E. Wood and W. E. C. Moore; *Virginia Agricultural Experiment Station*.

In experiments conducted at the Virginia Agricultural Experiment Station five methods for measuring the activity of cellulose-digesting organisms in the bovine rumen were compared. As a result of these experiments it was concluded that the most reliable and reproducible method was that recommended by Henderson, Horvat, and Block, which consisted of inoculating samples of vegetable parchment with rumen fluid, and recording the percent weight loss after an incubation period of 24 hours. An effort was made to determine the type activity being measured and its correlation to the pH of the rumen contents.

13. FREEZING BULL SEMEN.

Paul M. Reaves, R. B. Potts, and E. A. Drinkwater; *Virginia Polytechnic Institute*.

Semen was frozen by placing ampules of diluted semen in methyl alcohol at 40° F. in a thermos jug. Dry ice was added to the alcohol to lower the temperature at rates of 2 to 4° F. per minute until 5° F. was reached. Below this temperature faster cooling was employed to reach the melting point of dry ice (-110° F. or -79° C.) Storage was maintained by packing the thermos bottle with dry ice and holding it in an ice cream hardening room.

The frozen semen was thawed by placing in water at 100° F. The recovery rate was in the range of 40 to 60% motile sperm.

Twelve cows were inseminated with the semen. Five have been reported pregnant by rectal examination.

In another trial semen was handled similarly, but frozen to -4° F. (-20° C.) and stored in the ice cream hardening room at around 0° F. This gave very little recovery of motile sperm.

#### 14. VARIETY, TYPE, YEAR AND LOCATION EFFECTS ON THE CHEMICAL COMPOSITION OF PEANUTS.

James F. Eheart, R. W. Young, and Allen H. Allison; *Virginia Agricultural Experiment Station*.

Variety had a greater influence on all constituents studied than year.

Location had a greater influence on thiamine and riboflavin and hay protein than variety.

Spanish-type kernels were higher in protein and Virginia-type were higher in niacin and hay protein.

The higher the content of protein and oil in the kernel and protein in the hay, the greater was its varietal variability.

Variety x year interaction was significant for all constituents studied except thiamine. Variety x location interaction was significant only for riboflavin.

Mean protein, riboflavin and niacin contents were considerably higher and thiamine contents 50% higher than FAO values. Protein content of the hay was practically the same as Morrison's value.

Variety J-11-L and Introduction 149-637 had the highest nutritive value and could well be used in future peanut breeding studies.

#### 15. FACTORIAL EXPERIMENTS GIVE VALUABLE INFORMATION ON HOW TO FERTILIZE IN VIRGINIA.

Russell K. Stivers, P. T. Gish, G. D. Jones, and Boyd Harshbarger; *Virginia Agricultural Experiment Station*.

A factorial fertilizer experiment was initiated in 1950 on a Frederick silt loam near Staunton and a Davidson clay loam near Orange. Four rates of phosphate and three rates of potash fertilizer in all factorial combinations were applied each year in a three-year rotation of corn, wheat, and red clover hay.

Increases in yields were obtained with all crops on both soils as the rates of phosphate fertilization increased from none through 60 pounds per acre of  $P_2O_5$ . Corn had the smallest and hay the largest percentage increase in yields. As the rates of potash fertilization of the Frederick soil increased from none through 50 pounds per acre of  $K_2O$ , large increases in the yields of hay and wheat were obtained. Increases in the yields of corn were relatively smaller. On Davidson soil which tested high in available potash there were no significant differences associated with potash fertilization.



16. CONTROL OF THE STING NEMATODE ON PEANUTS WITH AN ETHYLENE DIBROMIDE-VERMICULITE MIXTURE.

Lawrence I. Miller; *Virginia Agricultural Experiment Station, Holland.*

Liquid soil fumigants for nematode control are usually applied under pressure with attachments designed to discharge the fumigant at given rates and depths. Standard fertilizer dispensing machinery might possibly be used to apply the nematocides if a satisfactory free-flowing absorbent for the fumigant could be found. Vermiculite was tested as an absorbent for ethylene dibromide at Suffolk, Virginia, in 1954. This free-flowing mixture was applied 5 inches deep in a furrow along the drill row at the rate of 0.5 pounds per 100 feet of linear row, and ethylene dibromide at the rates of 21, 31, and 42 pounds per acre. These mixtures were effective in controlling the sting nematode and correcting the stunted plant disorder. Ethylene dibromide used at the rate of 21 pounds per acre resulted in a 900-pound increase in yield of nuts, and gave the highest net return.

17. HIGHLY CHLORINATED STUDIES IN THE RAT AND THE CALF.

B. E. Joyce, W. B. Bell, and R. W. Engel; *Virginia Agricultural Experiment Station.*

*In vitro* and *in vivo* studies on the metabolism of highly chlorinated naphthalenes, causative agents of Bovine Hyperkeratosis, were undertaken in the albino rat and the calf. *In vitro* investigations indicate liver to be an active metabolizing organ for this compound in both animals.

Balance studies, investigating the relationship of absorption of hexa- and octachloronaphthalene to their relative toxicities, showed that of 5 mgs. of each fed, hexachloronaphthalene, the more toxic of the two, was absorbed to 91.8%. Octachloronaphthalene was absorbed to 83.5%.

Studies on the possible formation of conjugated products as a means of highly chlorinated naphthalene metabolism in the rat give evidence of the excretion of such conjugates of hexa- and octachloronaphthalene in the feces. Conjugation to the extent of 50% of the recovered chlorinated naphthalenes was observed.

18. GROWTH HORMONE CONCENTRATION IN SWINE PITUITARIES.

Bryan Baker; *Virginia Agricultural Experiment Station.*

Assays of the anterior pituitaries of animals ranging in age from the 56 day old fetus to 1400 day old mature animals were conducted. In addition, certain body measurements of the donor animals were made: body weight, carcass composition, long bone length, and organ weight. The total amount of growth hormone of the pituitary (unit potency X. A. P. wt.) was low in young animals and increased rapidly as the animals aged. During the phases of most rapid growth the amount of available hormone was high and during phases of slower growth the hormone titre per unit of body weight was constantly low. It appears that rapid

growth continues only so long as there is a high concentration of growth hormone available, and that the slow growing phases result from a dilution of the growth hormone to such an extent that active growth is no longer possible.

#### 19. CHANGING CONCEPTS IN MILK SANITATION.

G. S. Kennedy; *Roanoke Health Department.*

Effective milk sanitation by regulation, developed since 1900, has witnessed such rapidly changing concepts in all aspects as to pose a continuing problem for milk inspectors.

With pasteurization now recognized as basic, other developments include electric milking, cooling; glass pipelines, stainless steel; bulk cooling, hauling; homogenization; air-tight separators, clarifiers; hi-short pasteurizers; permanent pipelines, in-place cleaning, bulk dispensers; phosphatase tests, coliform, and psychrophilic counts.

Mileposts in Roanoke's milk control program: 1911, Health Department organized, dairy inspection started; 1926, Grading Ordinance passed; 1927-29, average bacterial count of pasteurized milk reduced from 83,000 to 2,200; 1939, P. H. S. standard ordinance passed; 1946, 100% pasteurization required.

It is interesting that Roanoke's infantile diarrhea death rate, averaged by 5-year periods, 1912 through 1951, declined from 88.6 for first period to 2.5 for last. Most dramatic drop from 68 in 1922-26 to 27.2 in 1927-31 occurred simultaneously with greatest milk improvement.

#### BUSINESS MEETING

The annual business meeting was held at the close of the session, May 13, 1955. The nominating committee composed of S. F. Thornton, Chairman; E. M. Dunton, Jr.; and Lawrence I. Miller presented the following nominees for 1955-56: *Chairman*, R. W. Engel; *Vice Chairman*, P. M. Reaves; *Secretary*, James W. Midyette, Jr.; *Section Editor*, R. K. Stivers.

The report of the nominating committee was accepted and those nominated were elected for next year's officers.

The desirability of interesting persons in fields related to agriculture to become affiliated with the Agricultural Science Section was discussed. It was recommended that efforts be made to attract these people to Academy membership and meetings.

MINUTES OF THE  
SECTION OF  
ASTRONOMY, MATHEMATICS, AND PHYSICS [2]

H. Y. LOH, *Chairman*

J. GORDON STIPE, JR., *Acting Secretary*

F. L. HEREFORD, *Section Editor*

FRIDAY, MAY 13, 1955 — —10:00 A.M. — ROOM 11,  
BURRUSS SCIENCE HALL

1. SCATTERING OF 0.2-MEV ELECTRONS BY GOLD FOILS\*.

W. G. Pettus, H. G. Blosser, and F. L. Hereford.

Recent experiments<sup>1</sup> on large angle scattering of 0.15 – 0.4 Mev electrons by gold and platinum foils indicated appreciable discrepancies between experimental and theoretical<sup>2</sup> angular distributions. In order to check these experimental deviations from the otherwise well-established theory, we have made another measurement of the angular distribution of scattered electrons. Electrons of approximately 0.19 Mev were supplied by a resonant cavity accelerator<sup>3</sup> and after magnetic analysis were focused on a gold foil of 0.202 mg/cm<sup>2</sup> surface density. The foil was centered in a 12" diameter scattering chamber with exit ports to allow counting of scattered electrons at angles between 60° and 150° relative to the incident beam. The background rate observed with a blank foil holder was subtracted from the counting rate at each angle. Comparison of these data with theoretical results indicates agreement to within 10%, considerably better than in the previous work.

2. TEMPERATURE EFFECTS IN THREE QUANTUM ANNIHILATION OF POSITRONS.

R. T. Wagner and F. L. Hereford; *University of Virginia*.

The ratio of three quantum to two quantum annihilation of positrons in ice and in zinc has been investigated in the 4° – 300° K. temperature range. The positron source (Na<sup>22</sup>) was prepared by dissolving sodium chloride in distilled water in a 5 ml flask which was then placed at the bottom of a Dewar. The ratio of three photon to two photon annihilations at several fixed low temperatures was then measured using a triple coincidence circuit. An approximately linear decrease in this ratio is noted with decreasing ice temperature similar to results in teflon.<sup>4</sup>

Using the same apparatus, the above ratio was measured for positrons annihilation in Zn in which the positron emitter (Zn<sup>65</sup>) was the absorber; here no temperature effect is observed. The correlation of these results

\* Supported by Office of Ordnance Research.

<sup>1</sup> E. Kinzinger, Z. Naturforsch. 8a, 312 (1953).

<sup>2</sup> N. F. Mott, Proc. Roy. Soc. (London) A124, 425 (1929).

<sup>3</sup> F. L. Hereford, J. Applied Phys. 18, 956 (1947).

<sup>4</sup> R. L. Graham and A. T. Stewart, Can. J. Phys. 32, 678 (1954).



with data<sup>5</sup> on positron lifetimes will be discussed together with results of other concurrent investigations of annihilation of positrons.

### 3. DESIGN OF THE V. P. I. 1.5 MEV PRESSURIZED ELECTROSTATIC ACCELERATOR.

T. M. Hahn; *Virginia Polytechnic Institute.*

Under construction at Virginia Polytechnic Institute is a horizontal pressurized electrostatic accelerator with a design limit of 1.5 to 2.0 Mev. The accelerator is to be enclosed in a 4-foot diameter removable pressure tank, 8 feet long. Working pressure is to be 150 psig, and a gas drying and storage system is being installed. Provision is incorporated for later conversion to a 4 Mev vertical installation using a new base plate with an additional 4 feet of tank length. The insulating column consists of three 3-inch Textolite tubes carrying aluminum corona rings. The ion source is of the Moak radio-frequency type, and power for the ion source and associated circuits is provided by a 500 watt permanent magnet alternator being built into the upper charging pulley. The accelerating tube is 39 inches long and is being formed of spun aluminum (2-S) electrodes and Isolantite insulators cemented together with Vinyl thermal cement. Energy control will be effected by a 90 degree magnetic analyzer and corona feedback system.

### 4. CLOSED EXPRESSIONS FOR TWO TRIGONOMETRICAL SERIES.

M. Stippes.

Let

$$(A) \quad W(x, y) = \frac{4}{\pi^4 ab} \sum_{m=1}^{\infty} \sum_{n=1}^{\infty} \frac{\sin \frac{m\pi\xi}{a} \sin \frac{n\pi\eta}{b} \sin \frac{m\pi x}{a} \sin \frac{n\pi y}{b}}{\left(\frac{m^2}{a^2} + \frac{n^2}{b^2}\right)^2}$$

The purpose of this note is to obtain closed expressions for  $\frac{\partial^2 w}{\partial x^2}$ ,  $\frac{\partial^2 w}{\partial y^2}$  in terms of Weierstraussian elliptic functions  $\rho(z)$  along with the associated quantities  $\zeta(z)$ ,  $\rho(z)$ .

This is accomplished by noting that (A) is the solution to the following boundary value problem:

$$\begin{aligned} \nabla^4 w &= 0 \text{ in } R \text{ \{R is the rectangle } x=0, x=a, y=0, y=b\}, \\ w &= 0, \nabla^2 w = 0 \text{ on the boundary of } R, \end{aligned}$$

<sup>5</sup> R. E. Bell and R. L. Graham, Phys. Rev., 90, 644, (1953).

$$w(x, y) - \frac{1}{8\pi} r^2 \log r \text{ is analytic in } R,$$

$$\{r^2 = (x-\xi)^2 + (y-\eta)^2\},$$

and, additionally, by making certain observations concerning the nature of harmonic functions.

## 5. THE STIELTJES INTEGRAL IN N-DIMENSIONAL SPACE.

E. J. McShane; *University of Virginia*.

The Stieltjes integral, originally defined in one-dimensional space, can easily be defined in space of  $n$ -dimensions. The same is true of the modified form of the Stieltjes integral studied by McShane and Botts. However, two of the known theorems for the case of one dimension cannot be immediately extended to the case of  $n$  dimensions. These are the following: (I) If  $f$  is integrable with respect to  $g$ , there is no point at which both  $f$  and the difference-function  $\Delta g$  are discontinuous. (II) If  $f$  is integrable with respect to  $g$ , and  $g$  is of bounded total variation, then  $f$  is also integrable with respect to the total variation of  $g$ . In this paper a lemma is proved which makes it possible to prove that these theorems both are still true in  $n$  dimensions.

## 6. THE MOTIONS AND DISTRIBUTION OF RED DWARF STARS.

George S. Mumford, III; *Leander McCormick Observatory, University of Virginia*.

In 1941 Vyssotsky inaugurated a survey of objective prism spectral plates at this observatory with the purpose of discovering red dwarf stars, spectral types dK8—dM5. This survey has been completed, and it is now possible to make a more accurate analysis of the motions of these stars than was possible previously.

The components of the velocities along the axes of the velocity ellipsoid have been computed. The frequency of the components along the axis directed towards the galactic center and anticenter is as symmetrical as one would expect it to be. The distribution of the components along the axis in the direction of rotation and the opposite direction is strongly asymmetrical; the asymmetry is present at velocities around 25 km/sec. It is interesting to note that the largest velocity in the direction of rotation is 54 km/sec while that in the opposite direction is 171 km/sec.

The quantity mass times the square of the total dispersion is found to be constant. This suggests a quasi-equipartition of energy among these stars.

A projection of the positions of the red dwarfs on the galactic plane indicates they are uniformly distributed in space. Any apparent clustering is found to be only an effect of projection when the distribution perpendicular to the galactic plane is investigated. All the evidence suggests that the red dwarfs are probably old stars.

## 7. ELECTRODELESS DISCHARGE THROUGH GASES AT LOW FREQUENCIES.

Paul S. Nekrasov and H. Y. Loh; *Virginia Polytechnic Institute*.

A study of the instantaneous variations and fluctuations of the electrodeless discharges through mercury vapor, air, and argon at the lowest frequencies used (60 and 400 cps) revealed that the light intensity variation produced was in the form of grouped peaks, whose average height and number per group depended on such factors as the gas pressure, the kind of gas used, terminal voltage, distance between the terminals, etc.

Discharges produced at radio frequencies (80 to 1100 kc) exhibited no apparent periodic variation. No peaks were observed under any circumstances, except when the applied r-f was modulated by a low-audio modulation envelope, in which case the wave shapes were in the form of the applied modulating wave.

The point of transition from the regular wave shapes to the disorderly oscillations (noise) produced at r-f is yet to be determined.

General appearance of the discharge column at r-f was that of a uniform column separated by dark spaces moving closer together as the pressure was decreased.

Variation of the break-down and extinction potential with pressure was found to be nearly linear, the potentials increasing as the pressure was increased. It was found that less load current was drawn by the discharges as the pressures were increased.

All work was done for sine wave terminal voltage variation, unless otherwise specified.

## 8. REFLECTED FRINGES OF MULTIPLE-BEAM INTERFERENCE.

H. Y. Loh; *Virginia Polytechnic Institute*.

A more general formula than Airy's for the reflected fringes produced by multiple-reflection has been worked out. It requires no restriction on either reflectivity or absorption of the reflecting surfaces. This new formula reveals not only the contour but also the contrast of the fringes.

Theoretical results, as well as photographs of the fringes obtained by combining various surfaces, are shown. Conditions for producing interference patterns of high contrast and sharpness are also discussed.

## 9. ETCH PITS.

Melvin M. Levine; *University of Virginia*.

When a crystal is exposed to an undersaturated medium, etch pits sometimes occur at places where dislocations meet the crystal surface.<sup>6</sup>

Conditions of undersaturation necessary for this to happen are investigated in terms of nucleation, and the rate of evaporation from the rest of the surface is shown, for ordinary densities of dislocations, to be negligible in comparison with that from the pits for undersaturations at which the process begins.

<sup>6</sup> Cabrera, Levine, Plaskett, *Phys. Rev.* 96, 1153 (1954).



## 10. LATTICE RELAXATIONS AROUND LATTICE IMPERFECTIONS.

George L. Hall; *University of Virginia.*

A theoretical description of the distorted structure of a simple crystal in the region surrounding a vacancy is presented. In a face-centered cubic, rare-gas crystal at the absolute zero of temperature, the twelve first nearest neighbors to the vacancy shrink inward only slightly, whereas the remainder of the crystal expands about the vacancy. It is shown that other authors<sup>7, 8, 9</sup> have applied linear elasticity theory to arrive at results contrary to those reported here. However, the correct use of linear elasticity theory is shown to be inadequate for a proper description of the vacancy.

Further, calculations of the lattice relaxations around a vacant site as a function of temperature and pressure are described to some extent.

## 11. SURFACE ENERGY AND SURFACE POTENTIALS OF METALS.

R. J. McIntyre; *University of Virginia.*

The approximations necessary to justify the free electron model of metals are examined. It can be shown that to a fair approximation, the valence electron wave functions may be considered to be solutions of the equation

$$\left[ -\frac{\hbar^2}{2m} \nabla^2 + V(\mathbf{r}) \right] \phi_i = \lambda_i \phi_i$$

$$\text{where } V(\mathbf{r}) = e^2 \int \frac{\sum_i |\phi_i(\mathbf{r}^1)|^2 - \rho_+(\mathbf{r}^1)}{|\mathbf{r}^1 - \mathbf{r}|} d\mathbf{r}^1 - \\ e^2 \int \frac{\sum_{i,j} \phi_j^*(\mathbf{r}^1) \phi_i(\mathbf{r}) \phi_i^*(\mathbf{r}) \phi_j(\mathbf{r}^1)}{\sum_{i,j} |\phi_i(\mathbf{r})|^2 |\mathbf{r}^1 - \mathbf{r}|} d\mathbf{r}^1 + \Sigma(\mathbf{r})$$

$e\rho_+(\mathbf{r})$  is a uniform positive charge distribution of  $e$  per atomic volume everywhere inside the lattice, terminating at the surface in a regular network of polyhedra which follows the structure of the crystallographic face, and  $E(\mathbf{r})$  is a calculable constant everywhere inside the lattice. Since  $\sum_i |\phi_i(\mathbf{r})|^2 = \rho_+(\mathbf{r})$  everywhere inside the metal except in the vicinity of the surface, the first term in  $V(\mathbf{r})$  is seen to be the potential due to a dipole layer on the surface which differs from one crystallographic face to another. Preliminary calculations yield results which are consistent with the few existing measurements of differences in surface potentials.

The corresponding expression for the energy yields terms proportional

<sup>7</sup> Frenkel, J.: Kinetic Theory of Liquids, Oxford Press, 1946.

<sup>8</sup> Machlup, S.: Baltimore Meeting of the American Physical Society March, 1955.

<sup>9</sup> Tucker and Sampson: KAPL — 1037.

See also, Nachtrieb, N. H. and Handler, G. S.: Acta Metallurgica, 2, 797, 1954.

to the surface area which are also consistent with the experimentally measured values of the surface energy.

## 12. INTERFERENCE FRINGES OF BEATS INVESTIGATED WITH SUPERPOSED TRANSPARENCIES.

L. G. Hoxton; *University of Virginia*.

The findings of a communication at the 1947 meeting, when it was shown that these fringes were Cartesian ovals in motion, are extended here, making use of a familiar phenomenon as a research tool on the sophomore level. It is flexible, labor saving, and suited to lecture demonstrations.

Photographic transparencies of a set of equally spaced concentric circles, when superposed, produce fringes of demonstrably the same form and like width as those produced by circular waves. These "artificial" fringes are projected on a screen and watched while conditions are varied.

The ovals may degenerate into circles or hyperbolas but, in general, are all closed curves, a finite number enclosing the source of higher frequency, an infinite number enclosing both. Some other elementary facts are as follows: The fringe velocity is proportional to the fringe separation at each point in the field. If  $c$  is the common wave velocity and  $\lambda_1 < \lambda_2$  then along the line of sources, outside and between them respectively: The fringe velocities are  $c$  and  $|c| (\lambda_2 - \lambda_1) / (\lambda_2 + \lambda_1)$  directed from 1 to 2, while the fringe spacings are  $\lambda_1 \lambda_2 / (\lambda_2 - \lambda_1)$  and  $\lambda_1 \lambda_2 / (\lambda_2 + \lambda_1)$ .

Professor Linfield discussed the inflexions at the 1948 meeting. Williamson's *Differential Calculus* 8th Ed. 1895, Longmans, discusses the ovals. The technique of transparencies has been systematically used by R. W. Pohl in his *Einführung in die Physik*, Vols. 1 and 3, Berlin Springer 1931, 1940.

## 13. INFRA-RED DISPERSION IN THE REGION OF LARGE ABSORPTION BANDS.

Melvin A. Pittman; *Madison College*.

Measurements on the dispersion of  $\text{CS}_2$  were made in the region of the large absorption bands. The apparatus consisted of two infra-red spectrometers in series, the first serving as a monochromator for the second with which the measurements were made. The first spectrometer was the conventional type with a rock salt prism while the second had a hollow prism with rock salt sides.

Thermocouple currents were amplified with a Moll and Burger double galvanometer arrangement.

## BUSINESS MEETING

At its business meeting, the membership elected the following officers: *Chairman*, J. Gordon Stipe; *Secretary*, Melvin A. Pittman; *Section Editor*, Frank L. Hereford.

## MINUTES OF THE SECTION OF BACTERIOLOGY [3]

H. J. WELSHIMER, *President*

WILLIAM F. LAWRENCE, *Vice-President*

MILES G. BOWLES, *Secretary-Treasurer*

J. DOUGLAS REID, *Section Editor*

### 1. SOME PROBLEMS IN THE SIMPLIFICATION OF *Endamoeba histolytica* CULTIVATION MEDIA.

E. Clifford Nelson and Muriel M. Jones; *Medical College of Virginia.*

Agar slant cultures of *E. histolytica* were found to grow better if the saline was replaced after twelve hours' incubation. Subsequent tests showed that a single washing of the sterilized rice flour has a similar effect and even enables growth of the amoeba in a simple phosphate buffered saline suspension of the powder. The addition of hemoglobin powder and mucin powder was found to enhance growth. Antibiotic inhibition of the bacterial flora of rice flour hemoglobin cultures was found to prevent *E. histolytica* growth. Survival was improved by addition of yeast factor, anaerobic conditions, and mucin, but complete replacement of the bacterial component has not been achieved.

### 2. CONTAMINATION IN BANK BLOOD.

Abraham L. Rosenzweig; *Veterans Administration Hospital, Richmond.*

A brief review of the problem of contamination in stored bank blood is presented. The negative findings of preliminary studies on contamination are presented, namely, with 120 samples collected by physicians when transfusions were started and with 98 discarded bottles of blood ranging in age from 7 days to 3 months. A preliminary report on a possible source of contamination of blood through minute holes remaining in rubber stoppers after withdrawal of puncture needle is presented and recommendations for correction are made.

### 3. SEROLOGICAL STUDIES OF *Lactobacilli*.

P. Arne Hansen and Robert H. Miller; *Department of Bacteriology and the Live Stock Sanitary Service Laboratory, University of Maryland, College Park.*

The subgenus *Thermobacterium* of *Lactobacillus* has been studied antigenically using the agglutination technique of Williams and Orland. *L. lactis* (Orla-Jensen) Holland has an antigen not described so far in other species of the genus. It seems distinct from the antigens A, B, C, D, E, F, G, H, I by Williams and Orland, from other homofermentative



lactobacilli. It is proposed to call it K or in the new terminology by Williams, Norris and György, 1-10. Rabbit sera prepared from *L. lactis* strain Dorner ATCC 8000 absorbed with cells of *L. casei* strain Tittsler 318, seemed specifically to agglutinate *L. lactis*.

4. AN UNUSUAL, SMALL, GRAM POSITIVE ROD ISOLATED FROM SPINAL FLUID.

H. J. Welshimer; *Department of Microbiology, Medical College of Virginia.*

The organism isolated from spinal fluid is a small rod generally 0.5 x 1.4 microns in dimension. On direct examination of spinal fluid the organism stained gram negatively. The cells of very young cultures stain gram positively. After 18 hours incubation, increasing numbers of the bacteria become gram negative. The colonies are non-hemolytic on sheep's blood agar plates, reaching a maximum size of about 4 mm. after 4-5 days at 37° C. The colonies are grey, smooth, entire, round, and slightly convex. Good growth is obtained on brain veal agar slants at 37° C., and a characteristic tackyness develops. No growth is obtained on ordinary peptone agar. Cultures on brain heart infusion broth show motility after 4-6 hours incubation at 37° C.

Acid is not produced on enriched media containing rhamnose, dextrose, inulin, xylose, lactose, mannitol, sucrose, salicin, or dextrin. The organism does not produce any ocular involvement when rubbed onto the conjunctivae of rabbits. Agglutination reactions are obtained only in low dilutions of known *Listeria monocytogenes* antiserum.

5. A COMPARISON OF THE ORIGINAL LOWENSTEIN MEDIA WITH JENSEN'S MODIFICATION OF LOWENSTEIN IN THE CULTURE OF *Mycobacterium tuberculosis*.

W. A. Dorsey and Jo Soles; *Department of Public Health, Richmond.*

The results of culture studies testing a large number of sputa on the original Lowenstein's medium and Jensen's modification indicate that the original Lowenstein medium is superior for the isolation of the human *Mycobacterium tuberculosis* strains, whereas the Jensen modification is better for the isolation of bovine tuberculosis strains.

6. HUMA TISSUES IN TISSUE CULTURE.

A. E. Feller

*Department of Microbiology, University of Virginia, Charlottesville.*

The problems and methods involved in the use of human tissue as a medium for isolation and cultivation of viruses associated with respiratory tract infections were discussed.

7. A STUDY OF SOME RACIAL DIFFERENCES WITH RESPECT TO TUBERCULOSIS.

Margaret S. Anderson; *Madison College, Harrisonburg.*

A study was made of tuberculosis mortality among the negro and white residents of each Virginia county. The tuberculosis mortality of the races was followed over a period of ten years. The tuberculosis mortality among the negroes after ten years dropped to a level equal to that of the white race at the beginning of the ten-year period. The mortality among the white race also dropped over the same period; however, the decline was less than in the case of the negroes. The ratio of negro to white tuberculosis deaths was less at the end of the ten-year period than at the beginning.

8. THE TUBERCULOSTATIC ACTIVITY OF AQUEOUS EXTRACTS PREPARED FROM SELECTED MAMMALIAN TISSUES.

Quentin N. Myrvik; *Department of Microbiology, University of Virginia, Charlottesville.*

(No abstract available.)

NEW OFFICERS

Effective January 1, 1956, the officers will be: *President*, A. L. Rosen-sweig; *Vice-President*, Wesley Volk; *Secretary-Treasurer*, Mrs. Barbara H. Caminita; *Section Editor*, P. Arne Hansen.

## MINUTES OF THE SECTION OF BIOLOGY [4]

ROSCOE HUGHES, *Chairman*

JACQUES RAPPAPORT, *Vice-Chairman*

JACK D. BURKE, *Secretary*

ROBERT T. BRUMFIELD, *Section Editor*

### 1. THE INHERITANCE OF FRUIT-SHAPE IN *Cucurbita moschata*.

A. M. Showalter; *Madison College*.

Ten fairly distinct true breeding varieties differing in fruit-shape have been derived from a single ancestor in fifteen generations of inbreeding and selection. These varieties differ markedly in proportion of thickness to length of fruits.

Crosses of varieties that differ only slightly generally give  $F_1$  fruits of intermediate shape and high uniformity. These  $F_1$  when selfed give  $F_2$  populations somewhat more variable than the  $F_1$ , and in some cases the range of variation exceeds the difference between the parental inbred strains. One cross gives  $F_1$  fruits distinctly longer than either of the parents. In another cross the  $F_1$  was back-crossed to one of the parents and gave fruits shorter than the  $F_1$  or either of the inbred parents.

$F_1$  plants frequently manifest hybrid vigor, and this may be assumed to affect fruit shape in some cases.

It seems evident that many pairs of alleles are concerned with these differences of fruit-shape.

### 2. GROWTH OF OYSTERS AT GLOUCESTER POINT, VIRGINIA.

J. L. McHugh; *Virginia Fisheries Laboratory*.

Oysters of various sizes, and usually of known age, have been held in trays suspended from the Laboratory pier for several years. At intervals, usually of one month, the oysters have been cleaned of marine growth, and their lengths and weights have been recorded.

Growth in length reaches two maxima during the year, in spring and fall. Growth in weight is more regular, although in some summers the rate of weight increase declines during the warm months. Growth in length apparently ceases during January to March inclusive, and growth in weight reaches a minimum.

The periods of most rapid growth do not coincide with the periods of heaviest oyster mortality. This knowledge has formed the basis of suggestions to oyster growers by which they may realize maximum yields.

### 3. CERTAIN BRYOPHYTES WITH CRITICAL DISTRIBUTION IN VIRGINIA.

Paul M. Patterson; *Hollins College*.

Examples of some recent finds which are critical in the sense of being



at or near their limits of geographical ranges were discussed. These fall into several categories as follows:

1. Nearctic species with Virginia at or near their southern limit.
2. Southern coastal plain and tropical species reaching our southern coastal plain, or confined to the southern appalachians in this area, or distributed over both areas.
3. Southern Appalachian endemics.
4. A disjunct from southwestern U. S., *Barbula Enrenbergii*.

4. OBSERVATIONS ON THE EFFECTS OF EYESTALK EXTIRPATION ON THE FEMALE CRAYFISH, *Cambarus longulus longulus* GIRARD.

Elizabeth M. Zipf; *University of Virginia*.

Among other effects, eyestalk extirpation in the crayfish is known to hasten moulting and egg-laying. Utilizing this knowledge, the eyestalks of the crayfish, *Cambarus longulus longulus*, were removed in order to incite egg-laying at a date earlier than is usual among females of this species. It has been found that among animals brought into the laboratory and maintained there, if their eyestalks are removed between October and March, they will lay within 10 to 15 days following the operation. A similar operation performed between the early part of March and mid-May, the normal egg-laying season, induces egg-laying within 6 to 10 days. Molting of such females occurs from 28 to 40 days after the operation, an average of about 20 days after the eggs are removed, or lost, from the pleopods. There are indications that a temperature of 11° to 13° C. (as opposed to 13° to 15° C.) will markedly retard both egg-laying and molting.

5. THE DEVELOPMENT OF THE OVULE, MEGASPOROGENESIS, AND MEGAGAMETOGENESIS IN *Typha angustifolia*.

Philip E. Graef; *University of Virginia*.

A single anatropous ovule arises from the upper inner surface of the ovary wall. The ovules are bitegmic on the convex surface and unitegmic on the concave surface. After the integuments have been differentiated and the apex of the ovule turns toward the stylar end of the ovary, a hypodermal cell of the nucellus is differentiated as an archesporial cell. As a result of two meiotic divisions a linear row of four megaspores is formed in all the ovules examined. The first chalazal spore is always larger than the other three spores, and as it develops into a 7-celled megagametophyte of the "normal" type the three micropylar spores disintegrate.

6. *Betula uber* (ASHE) FERNALD IN SMYTH CO., VA.

A. B. Massey and L. R. Hundley; *Virginia Polytechnic Institute*.

W. W. Ashe found a *Betula* near Rye Valley Station (now Sugar Grove) in 1914 and described it as *Betula nigra*, var. *uber*. Fernald raised it to the rank of a species. The taxon has not been rediscovered. The pres-

ent report is to call attention to it in hope that it may be rediscovered. The type locality was visited in 1954. *Betula nigra* was the only form seen.

7. A TENDENCY TOWARD CYCLIC DIMORPHISM IN FEMALE CRAYFISHES.

Horton H. Hobbs, Jr.; *University of Virginia*.

For more than three-quarters of a century the existence of a cyclic dimorphism in the male crayfishes of the subfamily Cambarinae has been known. This dimorphism, correlated with the spermatogenic cycle, has led a number of investigators to seek a similar phenomenon, correlated with the oogenic cycle, in the female crayfishes. No such dimorphism has been reported. In two Virginia crayfishes it has been observed that in early fall the cement glands, located in the sternal area of the abdomen of the females, assume a milky opaqueness which becomes more dense toward spring, the egg-laying season. Accompanying ovulation the glands become less opaque, are not visible after the spring molt, and do not reappear until immediately after the molt in late summer. It is of interest that the season in which the cement glands are apparent coincides with that of the so-called "first form" male, and that during the summer months when the cement glands are not obvious the male population is in the "second form". It has been demonstrated that the size and degree of opacity of the cement glands during the fall and winter months reflect the relative size and color of the oocytes within the ovary.

8. LIVER RESTORATION IN THE GOLDEN HAMSTER AFTER PARTIAL HEPATECTOMY, PRELIMINARY REPORT.

William L. Mengebier; *Madison College*.

The present study was instituted to determine whether the total weight of the liver of the Golden Hamster would be restored after partial hepatectomy. Animals were sacrificed at set intervals after removal of the left lateral lobes. The total weight of the remaining liver lobes of each animal was calculated as percentage of total body weight. Compensation in terms of increased weight in the remaining lobes became apparent twenty-four hours post operative. Complete recovery in terms of total liver weight took fourteen days. In all cases the remaining lobes became enlarged to the extent of changing the normal position of other abdominal organs.

9. A PRELIMINARY REPORT ON OBSERVATIONS OF THE EFFECTS OF EYE-EXTIRPATION ON TESTICULAR BEHAVIOR IN THE CRAYFISH.

Sam R. Telford, Walter H. Lewis, and John B. Kayan; *University of Virginia*.

Previous studies by other workers have shown that the sinus gland, located in the eyestalks of decapod crustaceans, produces a hormone which inhibits molting; further, that if this gland is removed, ecdysis occurs

shortly thereafter. It is also known that in the crayfish a cyclic sexual dimorphism in the male is correlated with the spermatogenic cycle and the usual spring and fall molts.

Experiments have been performed in order to determine whether or not the removal of the sinus glands has any effect on the spermatogenic cycle. While no conclusive generalizations have been drawn from this study, there is evidence that the removal of the eyestalk, and hence the sinus gland, tends to accelerate the spermatogenic cycle.

#### 10. THE SOMATIC CHROMOSOMES OF *Tulbaghia*.

W. S. Flory, Jr.; *University of Virginia*.

Whitaker and Flory (1955) give taxonomic and cultural notes on *T. violacea* Harv. along with brief chromosome descriptions based chiefly on the first microspore division, and mention that *T. cepacea* and *T. fragrans* also have chromosome numbers of  $n = 6$ . These are the first chromosome reports for the genus.

The present work extends the chromosome descriptions, especially of the somatic ones, for the 6 pairs found in *T. cepacea*, *T. fragrans*, and *T. violacea*. Five additional species (not definitely identified and still carried under number) of this South African genus have been studied. All have 6 pairs of chromosomes except *Tulbaghia* sp. No. 469S which has 12 pairs.

The complement of *Tulbaghia* sp. No. 7249 is rather representative of all the diploid species. The chromosomes do not vary greatly in length, but there are two longer ones (with sub-median centromeres), two medium ones (with median centromeres) and two shorter ones (one with sub-median, the other with sub-terminal centromeres). Following two hours of pre-treatment in .2% colchicine solution the respective lengths of these three chromosome groups are approximately  $17\mu$ ,  $14\mu$  and  $10\mu$ . The shorter chromosomes with sub-terminal centromeres are the most distinctive with a second constriction — and euchromatic region — quite near the centromere. This same type of chromosome, with tertiary constriction, is found in each species studied here but with variations in (1) position of the centromere, (2) position of the tertiary constriction, (3) the amount of heterochromatic material between the two euchromatic blocks, and (4) the number of chromosomes of this type.

#### 11. ALTERNANTHERA IN VIRGINIA.

A. B. Massey; *Virginia Polytechnic Institute*.

*Alternanthera philoxeroides* (Mart.) Griseb., the Alligator grass, is not listed in Gray's Manual as its recorded range northward is to North Carolina. It has been sent in from Hampton, Virginia, where it is reported as a pest.

#### 12. CHROMOSOME NUMBERS IN THE ARACEAE.

Gertrude Earl; *University of Virginia*.



Species belonging to two genera in the Araceae, *Zantedeschia* Sprengel and *Sauromatum* Schott, have been investigated cytologically. Six of the eight species of *Zantedeschia* listed by Traub in the most recent monograph of the genus have been examined in addition to three hybrids and four varieties. In all the material used here in this genus a chromosome number of 32 was found. One previous report has given the number of *Z. aethiopica* (Linn.) Sprengel as 24. The species examined were *Z. aethiopica*, *Z. albomaculata* (Hook. f.) Baillon, *Z. angustiloba* (Schott) Engl., *Z. Elliottiana* (Knight ex Watson) Engl., *Z. melanoleuca* (Hook. f.) Engl., and *Z. Rehmannii* Engl.

*Sauromatum*, also a small genus, has five or six species or perhaps forms of only one species. Two species, *S. guttatum* Schott and *S. nubicum* Schott, were examined and both found to have 26 chromosomes. A 2n number of 26 has been reported previously for *S. guttatum*.

No critical study of the Araceae has yet been made although some 25 genera have now been studied by cytologists. Basic numbers of 8, 9, 11, 12, 13, 14, and 17 have been reported, but present knowledge is too sketchy as yet to trace the evolution of the numbers.

### 13. WATER CONTENT OF VERTEBRATE EMBRYOS AND LARVAE.

A. M. Showalter and Harry Ruebush; *Madison College*.

Embryos and larvae of Amphibians in various stages are weighed, desiccated, and reweighed. From these weights the percentages of water are calculated.

Chick fetuses and a few mammalian fetuses are similarly investigated.

Results thus far indicate that the few statements in Embryology textbooks are not very accurate.

### 14. MONOECIOS TENDENCIES IN THE CRAYFISH, *Cambarus longulus longulus*, GIRARD.

W. H. Lewis; *University of Virginia*.

On sectioning more than one hundred crayfish testes from a population at Piney River, Nelson Co., Virginia, two form I males were observed with oocytes developing in their testicular lobes. As many as thirty-four oocytes found at random throughout each lobe and varying in diameter from 26-117  $\mu$ . appeared similar to ovarian oocytes in all morphological respects. At the present time there is insufficient evidence to hazard an estimate on the percentage of crayfish with an ovi-testis at this locality.

### 15. CHROMOSOME COMPLEMENTS OF SOME *Cyrtanthus* SPECIES IN SUBGENUS MONELLA COMPARED WITH THAT OF *C. sanguineus* IN SUBGENUS GASTRONEMA.

W. S. Flory, Jr.; *The Blandy Experimental Farm, University of Virginia*.

*Cyrtanthus angustifolius*, *C. falcatus*, *C. lutescens*, *C. Mackenii*, *C.*

*O'Brieni*, and *C. sanguineus* each have 16 somatic chromosomes. The first five species named are in subgenus *Monella*, while *C. sanguineus* is in subgenus *Gastronema*. The species in *Monella* have quite similar chromosome complements with 3 long chromosome pairs — one with median and two with submedian centromeres, and 5 shorter pairs with subterminal centromeres. *Cyrtanthus sanguineus* has a complement with a distinctly different appearance: 3 long chromosome pairs — with median, sub-median and sub-terminal centromeres, respectively; 1 medium — long pair with sub-median centromeres; 3 medium size pairs with sub-terminal centromeres; and 1 short pair with sub-terminal centromeres.

*Cyrtanthus lutescens*, *C. Mackenii*, and *C. O'Brieni* have been found to intercross readily with resulting hybrid progenies. Attempted crosses between *C. sanguineus* and *C. O'Brieni*, of separate subgenera, have failed.

Taylor has earlier found  $2n = 16$  in *C. parviflorus* of subgenus *Monella*, while Sato has reported  $2n = 22$  in a form identified as *C. obliquus* of the third subgenus, *Cyrtanthus* proper.

#### 16. OXYGEN CAPACITY STUDIES IN RELATION TO BODY WEIGHT IN ALBINO RATS.

Jack D. Burke; *University of Richmond*.

The oxygen capacity of the blood of albino rats was determined by the Roughton-Scholander micro-gasometric method as modified by Grant. Animals of different weights were studied in groups of eight, and the mean weights were reported in relation to mean oxygen capacities in volumes per cent. It was found that the mean oxygen capacity increased as the mean body weights increased.

#### 17. REVERSION OF *Stylonychia* GIANTS.

Stephen C. Bocksey; *Madison College*.

Giant, cannibal forms of *Stylonychia pustulata*, when isolated and maintained on a diet of *Bacillus subtilis* will revert to normal-sized organisms within 120 hours and within seven generations.

The highest division rate during this reversion takes place between the 48 to 96 hour period after isolation into a pure bacterial flora medium. During this period of higher reproductive rate the Feulgen stain on discarded generations indicates the presence of nucleo-proteins within the food vacuoles; 120 hour discards give a negative Feulgen stain.

Twenty-four hour bacteria feeding giants, the first generation raised on bacteria, revert to cannibalism when placed in a mixed culture of *Stylonychia* and bacteria.

Ninety-six hour generations, followed for two days by carmine in their food vacuoles, do not revert to cannibalism in a mixed culture of *Stylonychia* and bacteria.

## NEW OFFICERS

The following officers were elected at the Business Meeting: *Chairman*, John C. Strickland<sup>1</sup>; *Vice-Chairman* J. L. McHugh; *Secretary*, J. N. Dent.

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<sup>1</sup> Resigned because of other duties.



## MINUTES OF THE SECTION OF CHEMISTRY [5]

J. STANTON PIERCE, *Chairman*

RICHARD M. IRBY, *Secretary*

CARL J. LIKES, *Section Editor*

FRIDAY, MAY 13 — 9:00 A.M. and SATURDAY, MAY 14 — AUDITORIUM, WILSON HALL

Introductory Remarks — Chairman J. Stanton Pierce; *University of Richmond.*

### 1. THE EFFECTS OF VARIOUS CONSIDERATIONS ON THE AIR FLOW THROUGH A CIGARETTE.

P. M. Pedersen and E. S. Harlow; *American Tobacco Company.*

The airflow through an unlighted cigarette serves as a means of evaluating the ease or difficulty which a smoker may have in puffing and is one of the criteria used in quality control of manufacture. The relationship of certain physical characteristics of a cigarette, such as weight, circumference, length, moisture, and width of strand to airflow of cigarettes made from different types of tobacco have been studied. From this work it has been possible to determine correction factors for variations in weight, circumference, and length. Airflow is not materially affected by width of cut or by moisture content if other factors are kept constant. The Poiseuille relationship for laminar flow of a gas through porous media is substantially confirmed in the case of cigarettes.

### 2. X-RAY PHOTOELECTRON SPECTROMETRY.

Ralph G. Steinhardt, Jr.; *Virginia Polytechnic Institute.*

When a beam of x-rays irradiates a solid target, electrons are emitted with a spectrum that is characteristic of the target atoms. The energies of these electrons may be analyzed by a magnetic or electrostatic field and their relative intensities measured with an ultra-thin window Geiger-Muller counter. Because of the relatively low energies of x-ray photoelectrons, only those that originate in the surface or in the immediate sub-surface regions of the target can escape. The x-ray photoelectron spectrometer thus provides a convenient method for the analysis of surfaces and sub-surface regions of solids. Both qualitative and quantitative analysis can be performed non-destructively. The degree of roughness need not interfere with analysis, and the actual roughness may be determined if the RMS value is not less than about one micro-inch.

### 3. AN X-RAY AND METALLOGRAPHIC STUDY OF LARGE GRAIN TITANIUM.

Francis J. Denise; *Virginia Institute for Scientific Research.*

Large single crystals of high temperature *beta* phase titanium can be

prepared by a modification of the strain-anneal method, but recrystallization occurs on cooling.

Etching revealed the titanium rod to consist of a great many crystalline fragments which were oriented with respect to one another. This was confirmed by x-ray back reflection methods.

The results indicate strongly the existence of an orientation relationship between a low temperature hexagonal phase and a high temperature cubic phase.

#### 4. ACID AND BASE COMBINING CAPACITY OF ZEIN.

Carl J. Likes and Donald F. Koenig; *Virginia Institute for Scientific Research.*

As part of a general study of factors which influence the fiber forming properties of zein, the prolamine of corn, the acid and base combining capacities of zein in 85.0% by weight iso-propyl alcohol have been investigated. Titrations were made with a Beckman pH meter using 0.01 N HCl and NaOH, and were carried out under an atmosphere of helium. The total number of basic groups was found to be  $23.3 \times 10^{-5}$  moles per gram of zein. Corresponding values, based on published amino acid analyses of zein, were calculated to be  $18.3 \times 10^{-5}$  and  $25.9 \times 10^{-5}$ , respectively. The amount of acid bound by the alcohol system itself was determined and found to be negligible.

#### 5. SULFUR AND NITROGEN COMPOUNDS AS ANTIOXIDANTS AT ELEVATED TEMPERATURES.<sup>1</sup>

James W. Cole, Jr., Donald R. Campbell, and Robert N. Lawhorn; *University of Virginia.*

The heterocyclic structure of phenothiazine apparently is not the sole basis for its unusual antioxidant properties at 200° C. and higher. It has been shown that the reaction of the molecule with equivalent quantities of oxygen promotes species which also have antioxidant activity. The current report will show the relative activity of heterocyclic nitrogen and sulfur atoms and the effect of ring substitution on diphenyl systems, through a study of the anti-oxidant characteristics of selected compounds with strategic functional groups. Experiences will also be described with the functional systems on titanium, aluminum, copper, silver, and iron surfaces.

#### 6. AN IMPROVED SMOKING AUTOMATON.

A. E. O'Keeffe and R. C. Lieser; *Philip Morris and Co., Ltd., Inc.*

A constant volume, positive displacement, syringe type smoking machine is described. This machine may be assembled by modifying a commercially available basic unit.

<sup>1</sup>This research was conducted under Contract No. AF 33(038)-22947 with the United States Air Force, under the sponsorship of the Materials Laboratory, Wright Air Development Center, Air Research and Development Command.

The machine is very reproducible with regard to volume, duration and frequency of puff, and the puff pattern closely approximates that of some human beings.

Volume, duration, and frequency may be varied precisely and independently over wide ranges with little or no operational interruption.

Eight cigarettes may be smoked simultaneously but individually by use of eight puffing mechanisms.

The puff volume and duration are less sensitive to large pressure drops across cigarette and absorption train than is the case with other machines described in the literature.

The authors recommend that the steel balls and weights initially used in the value assemblies be replaced with sapphire balls and that a safety filter be employed to prevent valve sticking during prolonged operation.

#### 7. ELECTROCHEMICAL PREPARATION OF BORON.

Nelson F. Murphy, Richard S. Tinsley, and George F. Meenaghan; *Virginia Polytechnic Institute*.

A process for preparing boron by electrolysis of the molten alkali-alkali borofluoride-boron oxide mixture, at 750° to 875° C., with a cathode current density of 0.5 to 5.0 cathode amperes per sq. cm. was studied. The only appreciable impurity in the deposit is carbon which arises from decrepitation of the crucible and anode. The current efficiency of the process is about 73 per cent. A gas fired furnace is preferred to an electrically heated one, since the fumes are corrosive to the heating elements.

#### 8. SYSTEMATIC CHROMATOGRAPHIC ANALYSIS FOR METALS.

Harriett H. Fillinger; *Hollins College*.

A fairly complete scheme of chromatographic qualitative analysis for the metals of a first course of qualitative analysis has been developed.

Each of the separate groups of metals of classical schemes of qualitative analysis can be analyzed by this method in a few minutes. In addition to the handling of the individual groups of metals separately, the scheme is applicable to a general unknown containing eight to twelve kinds of metal ions with only a fraction of the separation of groups, and parts of groups, needed in classical methods of analysis.

Column chromatography requiring only the simplest of regular laboratory equipment is employed. Specially prepared alumina is the adsorbent used. The analyses can be accomplished by the chromatographic method in a small fraction of the time required by classical methods of qualitative analysis.

#### 9. GUEST LECTURE: FUNDAMENTAL RESEARCH AND THE TOBACCO INDUSTRY.

E. S. Harlow and H. R. Hanmer; *American Tobacco Company*.



Fundamental research on tobacco and tobacco smoke has been increasingly emphasized in the tobacco industry in the last decade. Originally directed primarily to development of methods for quality control in manufacture, it now is chiefly concerned with finding out the relationship between composition of tobacco and the taste and biological effects of tobacco smoke. To elucidate this major problem a thorough study of the composition of tobacco and smoke is required. The complexity of the tobacco plant and of the smoke itself requires the most modern techniques to isolate and identify the various components. Mass spectrometry, ultraviolet and infrared spectrophotometry, low temperature separation of gaseous constituents, the ultracentrifuge, and electron microscope are frequently employed. Tracer techniques with radioisotopes, particularly  $C^{14}$ , are also being used and are a means of separating and identifying tobacco precursor compounds of smoke constituents. Without such procedures, studies of this sort are almost impossible.

#### BUSINESS MEETING

A nominating committee, consisting of James W. Cole, William E. Trout, Jr., and Sidney S. Negus, nominated the following candidates as officers of the Chemistry Section for 1955-56: *Chairman*, Richard M. Irby, Jr.; *Secretary*, Mary E. Kapp; *Section Editor*, Carl J. Likes.

These officers were elected by a unanimous vote of the members present.

#### 10. DETERMINATION OF TRACE QUANTITIES OF NICKEL IN HUMAN BLOOD.

Maxwell L. Cluett and John H. Yoe; *University of Virginia*.

Gram-atom absorptivity values of several Ni(II) chelates were compared in order to select the most sensitive reagent for a spectrophotometric determination of trace amounts of nickel. The reaction between Ni(II) and sodium diethyldithiocarbamate was chosen and studied critically to determine the most suitable solvent, stability of reagent, effect of pH, blank characteristics, optimum concentration range, effect of foreign ions, etc. The reaction exhibits a gram-atom absorptivity of 37,300. A separation procedure based on the anion exchange behavior of Ni(II) and interfering metal ions in strong hydrochloric acid solution will be discussed.

#### 11. SPECTROPHOTOMETRIC DETERMINATION OF TRACE QUANTITIES OF MAGNESIUM.

Charles K. Mann and John H. Yoe; *University of Virginia*.

A new, sensitive method for the determination of trace quantities of magnesium has been developed. Procedures have been devised for the elimination of interfering elements and for the determination of magnesium in the presence of larger quantities of calcium.

12. TWO NEW COLORIMETRIC REAGENTS FOR THE DETERMINATION OF BORON.

Robert L. Grob and John H. Yoe; *University of Virginia*.

Two organic compounds that give sensitive color reactions with boron have been discovered, and a procedure for their use in determination of trace quantities of this element in plants and fruit tree leaves has been developed. A method for the rapid decomposition of the sample, with subsequent separation of boron, as the trimethyl ester, is described.

13. AN APPARATUS FOR THE STUDY OF IGNITION AND MASS TRANSFER OF DROPLET-VAPOR SYSTEMS.

W. E. Rice and S. S. Stein; *Experiment Incorporated*.

The apparatus is designed to permit a single droplet of a reactant to fall through an atmosphere of the vapor phase of another reactant with provision for determining the time of fall before ignition, in the case of combustion studies, or the degree of mass transfer, in the case of mass transport studies.

During the operation of the unit, a droplet falls from the drop producer at the top and passes a photocell, which starts an interval timer and also causes a sliding valve to open as soon as the drop is ready to enter the jacketed reaction zone containing the vapor reactant. A smooth separation between an original inert gas and the reactant vapor thereby exists when the drop enters the reactant zone. The light from the flame as a result of the reaction between the droplet and vapor causes a photocell, located at the bottom of the unit, to stop the interval timer. The apparatus can be rapidly disassembled for cleaning after each test.

The rate of mass transfer between the drop and the vapor is determined within the same unit, but with the introduction of a droplet catcher inside of the reactant tube. Drops are caught after falling various distances and analyzed.

14. THE EXPERIMENTAL DETERMINATION OF BURNING VELOCITY BY THE BUNSEN BURNER TECHNIQUE.

George J. Gibbs and Hartwell F. Calcote; *Experiment Incorporated*.

The burning velocities of various compounds have been investigated by many different observers in an attempt to understand the mechanism of flame propagation. This paper presents the procedure used at this laboratory, with data demonstrating the errors involved, a comparison with results from other laboratories, and the effect of moisture on flame propagation.

15. STUDIES OF IONIZATION IN FLAME BY MEANS OF LANGMUIR PROBES.

I. R. King and H. F. Calcote; *Experiment Incorporated*.

In order to determine the ion distribution through the flame front a

Langmuir probe, such as that used in studying electrical discharges in gases, was chosen as the measuring tool. By means of such an instrument it is possible to determine, among other characteristics of an ion plasma, the electron temperature and the positive-ion concentration. Although both parameters have been determined in this program, attention is directed mostly toward a determination of the ion concentration.

Results thus far indicate that the abnormally high ionization found in most flames is not due to impurities or to thermodynamically ionized nitric oxide. The arguments for this conclusion are:

(1) Flames of carbon disulfide and hydrogen sulfide contain very small concentrations of ions.

(2) Very lean flames at low temperatures have high ion concentrations.

(3) The ionization is concentrated in a very thin region comparable in thickness to the reaction zone.

(4) One cannot correlate the results at two pressures by assuming thermal ionization of contaminants.

#### 16. A NEW TECHNIQUE FOR STUDYING DUST EXPLOSIONS.

Lloyd E. Line, Jr. and Wendall J. Clark; *Experiment Incorporated*.

An apparatus has been built for producing a dust cloud that can be ignited under controlled conditions. The cloud is in the form of a moving stream of particles suspended in a oxidizer gas and is stable, uniform, and wall-free. It has about 12 inches of usable length and is ignited in a chamber containing observation windows. Provision has been made for varying gas flow, gas composition, system pressure, dust concentration, and particle size. The instantaneous control and measurement of the dust concentration is accomplished with a light-absorption apparatus.

Successful dust clouds have been made of finely-divided carbon black, charcoal, magnesium, boron, and lycopodium. Preliminary ignition experiments with some of these materials are described.

The apparatus will be used to obtain information that will further our understanding of the combustion of dusts.

#### 17. SOME REACTIONS OF BUTADIENE CYCLIC SULFONE.

Robert C. Krug and C. R. Tichelaar; *Virginia Polytechnic Institute*.

Sulfur dioxide and 1,3-butadiene undergo a 1,4 Diels-Alder type addition to give butadiene cyclic sulfone, a compound of relatively low thermal stability. Due to its acidic alpha hydrogen atoms, this sulfone will react with Gignard reagents, sodium hydride, and other bases. The sulfone also undergoes many addition reactions at the carbon-carbon double bond. Other properties and reactions of the butadiene cyclic sulfone will be illustrated.



## 18. HALOGENATED ISOPRENE CYCLIC SULFONES.

Robert C. Krug and Teh-Fu Yen; *Virginia Polytechnic Institute*.

The nucleus and the side chain of isoprene cyclic sulfone may undergo halogenation, and thus a number of halogen derivatives of this sulfone could be prepared. The following reactions involved in the synthesis of certain of these compounds will be discussed: the ionic and radical types of addition, the Wohl-Ziegler halogenation of the side chain, the allylic shift, dehydrohalogenation, and isomerization.

## 19. CHROMATOGRAPHIC SEPARATION OF A COMPLEX POLYNUCLEAR HYDROCARBON MIXTURE.

Frank A. Vingiello and Alexej B. Borkovec; *Virginia Polytechnic Institute*.

A mixture of three structurally related polynuclear hydrocarbons was prepared by the cyclization of 2-(2'-naphthylmethyl)-benzophenone and their separation was attempted by several methods. Four of the methods, i.e., crystallization, selective oxidation, molecular compound formation, and preferential adduct formation will be mentioned, while the fifth one, chromatography, will be discussed with regard to the following: (1) adsorbents, (2) solvents, (3) methods of separation and tracing, (4) selectivity, and (5) general aspects of the procedure.

## 20. THE DECARBONYLATION OF SOME CARBONYL BRIDGE COMPOUNDS.

Albert W. Lutz; *The College of William and Mary*.

The application of Schmidt's "double bond rule" to the decarbonylation of several carbonyl bridge compounds is considered. A more modern mechanistic explanation is attempted. The synthesis of cyclodecanone as an intermediate in the preparation of one of these model carbonyl bridge compounds is discussed in the light of the high speed stirring (10,000 r.p.m) technique as applied to the acyloin condensation.

## 21. A SUBMERGED COMBUSTION BOILER.

Gerald Golub; *Experiment Incorporated*.

A steam boiler which will provide for the intimate contact of the hot combustion gases with its boiler water will show many advantages. Its use, however, is limited to presently-used, closed condensing cycle units because of the presence of the non-condensable combustion gases in the steam and the necessity of pressurizing the air-fuel mixture to the steam pressure. The object of this investigation is to find a suitable heat transfer medium which would eliminate these disadvantages.

When the unit is operating, a lighted propane-air burner is submerged in a bath of a molten chloride salt eutectic which is held at 800-900° F. Circulation of the salt is provided by a jet pump which pulls the colder salt from the bottom of the unit past the burner where the liquid salt mixes with the hot combustion gases. The salt continues to cycle, but

the exhaust gases leave through a vent at the top of the unit. The heat is continually withdrawn from the salt bath by passing water through copper coils which encircle the unit. An electric heater is required to melt the original salt.

In a given boiler room a unit of this design utilizing high output ram-jet type burners and this method of heat transfer could increase steam production by three to six times its present capacity.

22. THERMODYNAMICS OF COMPLEX ION FORMATION.

Loren C. Hepler; *University of Virginia*.

The heats, free energies, and entropies of formation of a series of complex fluoride ions have been experimentally determined. These thermodynamic properties, especially the entropy, are interpreted in terms of what is known about the hydration of ions in solution and the bonding of one atom to another. The effects of polarization and molecular crowding in solution are also discussed.

23. THE STUDY OF FILMS ON CATALYTIC SURFACES WITH THE AID OF ELLIPTICALLY POLARIZED LIGHT.

Robert E. Cunningham and F. W. Young, Jr.; *University of Virginia*.

The use of elliptically polarized light allows the measurement of films of a few molecular layers thick on a surface. This technique has been applied to films on catalytic surfaces, and the thickness of the oxide film on the (111) face of copper during the catalytic reaction of hydrogen and oxygen has been studied for a variety of conditions.

24. THE RATES OF OXIDATION OF SEVERAL FACES OF A SINGLE CRYSTAL OF COPPER WITH THE AID OF ELLIPTICALLY POLARIZED LIGHT.

F. W. Young; *University of Virginia*.

The rates of oxidation of the (100), (111), (110), and (311) faces of a copper single crystal were determined at the temperatures 70°, 106°, 130°, 159°, and 178° C. by measuring the increase in thickness of the oxide film as a function of time. A polarizing spectrometer was used to measure film-thickness. Particular emphasis was placed on preparing a smooth strain-free surface of known orientation, and on eliminating small amounts of contamination. The results showed the great difference in the rate of oxidation with crystal face at these temperatures, the ratio of the thickness of the oxide on the (100) face to that on the (311) face being 12.5 for oxidation at 178° C. An analysis of the results according to the present theories of the oxidation of metals was presented.

25. STUDIES OF THE COORDINATION OF 1,3-BIS (TRIS-(HYDROXYMETHYL)-(-METHYL-AMINO)-2-PROPANOL WITH SOME CATIONS OF THE FIRST TRANSITION SERIES.

Velta Erdmanis and William E. Trout, Jr.; *University of Richmond*.

The coordination of 1,3-bis(tris-(hydroxymethyl) (-methyl-amino)-2-propanol with seven cations of the first transition series was studied by means of spectrophotometry and pH measurements. The composition of the complexes was studied by Job's method of continuous variations, where possible. Stability constants were calculated from potentiometric measurements of hydrogen-ion concentrations.

26. A FURTHER STUDY OF Fe (III) AND 1,3-BIS(TRIS-(HYDROXYMETHYL) (-METHYL-AMINO)-2-PROPANOL.

Jane Bell Gladding and William E. Trout, Jr.; *University of Richmond*.

Fe(III) and 1,3-bis (tris-(hydroxymethyl) (-methyl-amino)-2-propanol have been studied to determine the nature of the coordination compound which they apparently form.

Spectrophotometric studies were made at pH intervals of 0.5 from pH 2.5 to pH 12. A graph of absorption *versus* pH gives some significant results.

27. THE OXIDATIVE DETERMINATION OF HUMECTANT ADDITIVES IN TOBACCO.

H. E. Wright, Jr. and W. W. Burton; *American Tobacco Co.*

Large quantities of humectants are used by the tobacco industry as additives for the purpose of improving the moisture-retention properties of tobacco products. Glycerol, propylene glycol, diethylene glycol, triethylene glycol, and sorbitol are among the hygroscopic agents more commonly used by the manufacturers.

Mixtures of humectants are analyzed quantitatively by use of the periodate and dichromate oxidations. The periodate reaction is limited to those polyols having vicinal hydroxy or alcoholic functional groups, while the dichromate ion is not at all selective in its oxidative capacity. Thus, the periodate ion reacts quantitatively with glycerol and propylene glycol, but does not react with diethylene glycol or triethylene glycol. By taking advantage of the oxidizing properties of the periodate and dichromate ions, it is possible to evolve an analytical procedure applicable to the measurement of the humectant content of cigarettes.

28. SOME COMPARISONS OF ZEIN TEXTILE FIBER WITH FINE CLOTHING WOOL.

George L. Walker, Jr.; *Virginia-Carolina Chemical Corporation*.

Bulky amino acid residues distributed along polypeptide chains are thought to constitute the molecular units for both zein fiber and wool. The average amino acid residue weights of zein and wool keratin appear to be nearly identical. The structural similarity of the two fibers is further suggested by a comparison of their x-ray diagrams.



In such dry mechanical properties as tensile strength, ultimate elongation, tensile recovery, work recovery, work to stretch, Young's modulus, and compliance ratio, zein fibers are closely similar to 80's wool, cashmere, and vicuna.

In yarn manufacture both zein fibers and cashmere wool require less carding than is normal for coarser wools, and both are high in potential contributions to softness and fineness of texture of the yarns and fabrics into which they are incorporated.

29. SYNTHESIS AND CHEMISTRY OF 0-2,4-DICHLOROPHENYL 0,0-DIETHYL PHOSPHOROTHIOATE ("V-C 13 NEMACIDE") AND ITS ANALOGS.

Charles L. Harowitz; *Virginia-Carolina Chemical Corporation.*

The preparation and physical properties of 0-2,4-dichlorophenyl 0,0-diethyl phosphorothioate (the active ingredient in V-C 13 Nemacide) are covered. Synthetic methods are shown based on phosphorus trichloride, phosphorothioic chloride, and phosphorus pentasulfide as starting materials. Analogs of the diethyl ester are reported, and the effect of structural modifications on nematocidal activity are discussed.

30. THE DETERMINATION OF RESIDUES OF 0-2,4-DICHLOROPHENYL-0,0-DIETHYL PHOSPHOROTHIOATE ("V-C 13 NEMACIDE").

George R. Boyd; *Virginia-Carolina Chemical Corporation.*

A sensitive and accurate method of analysis has been developed for residues of 0-2,4-dichlorophenyl 0,0-diethyl phosphorothioate, the active component of "V-C 13 Nemacide", in soils and in fruits and vegetables. The method is based on hydrolysis of the phosphorothioate ester to liberate 2,4-dichlorophenol which is determined colorimetrically by its reaction under controlled conditions with 4-aminoantipyrine.

Optimum conditions have been determined for the hydrolysis of "V-C 13 Nemacide" and for the development of the red color with 4-aminoantipyrine.

Samples of treated soils and of fruits and vegetables grown in treated soils have been analyzed for residues by the procedure developed in this work.

31. THE PREPARATION OF SOME NEW AROMATIC KETONES.

Frank A. Vingiello and J. Robert Thornton; *Virginia Polytechnic Institute.*

The most common procedure for effecting the aromatic cyclodehydration of ketones involves heating them with a mixture of hydrobromic and acetic acids. Since this reaction mixture is also an effective hydrolyzing solution, it cannot be used to cyclize ketones containing hydrolyzable groups. We are currently developing cyclization procedures involving the use of anhydrous catalysts. As part of this research we have synthesized three new ketones: 4'-methoxy, 4'-chloro, and 4'-cyano-2-benzylbenzo-

phenone. We will describe, in detail, the syntheses which led to the above-mentioned ketones.

32. THE PREPARATION OF SOME METHYL- AND TRICHLOROMETHYL-*O*-BENZYL-PHENYL-CARBINOLS.

Frank A. Vingiello and Peter E. Newallis; *Virginia Polytechnic Institute*.

In the course of preparation of chlorinated anthracenes, some methyl- and trichloromethyl-*o*-benzylcarbinols were prepared. These compounds were synthesized by the addition of acetaldehyde or chloral to the appropriate Grignard reagent. In some cases the product isolated was an extremely viscous oil which had a wide boiling range. In such cases the alcohols were identified by converting them to their acetates, which were crystalline. The synthesis of the alcohols and their acetates will be described.

33. TRITYL ETHERS OF NEGATIVELY SUBSTITUTED ALCOHOLS.

J. S. Belew, J. O. Edwards,<sup>2</sup> and R. Layton; *University of Virginia*.

Trityl chloride reacts with a negatively substituted alcohol in the presence of a tertiary amine to produce the corresponding ether. This study is restricted to those substituted ethanols having three like negative substituents on the two position. The trityl ethers of some of these alcohols are obtained in good yields as solids, and they are recommended as derivatives for identification purposes. Structures of the ethers are supported by analytical evidence and infra-red spectra.

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<sup>2</sup> Brown University.

## MINUTES OF THE SECTION OF EDUCATION [6]

JACK H. BOGER, *Chairman*

DEFOREST L. STRUNK, II, *Secretary*

JAMES B. PATTON, JR., *Section Editor*

FRIDAY, MAY 13 ——— 9:00 A.M. — ROOM 27, WILSON HALL

### 1. AN APPLICATION OF THE INFORMAL READING INVENTORY.

Katherine Minor Anthony; *Madison College.*

The Informal Reading Inventory studies the subject's reading attitudes and abilities in an interview-test situation. The child reads from a series of school readers and the examiner uses a mimeographed record blank. Levels of achievement are secured in four areas: (1) word recognition, (2) oral reading, (3) silent reading, and (4) listening, including both vocabulary and comprehension. This Informal Reading Inventory furnishes data for diagnosis and remedial suggestions. It also indicates the grade level of materials to be used for the child's free reading and for teacher-directed or instructional reading.

An informal reading inventory was used as the core of individual reading analysis. A pattern has been developed for securing supplementary data concerning personal problems, reading interests, auditory and visual difficulties. A group inventory is being prepared for use by classroom teachers.

### 2. THE NEW SCIENCE.

Winfred P. Elson; *Calverton High School.*

### 3. THE PREDICTION OF ACHIEVEMENT IN HIGH SCHOOL BIOLOGY.

Alonzo M. Myster and Emily B. Murdock; *Virginia State College.*

The problem investigated in this study was to determine the relationship of total reading ability and selected reading factors to achievement in biology and at the same time investigate the value of mental age in predicting academic success in biology.

The variables considered in this study were general mental age, expressed in months, total reading ability and unit skills of reading, expressed in terms of grade level or placement and biology grades for first term, second term and average of the two terms. These biology grades were assigned values ranging from a value of four for A, to a value of zero for F.

The sizes of the correlations were small but of a size sufficiently large to make predictions possible. The errors of prediction will be in many cases very large. The relationship between general mental age and achievement in biology was greater than that between reading and achievement in biology. Although it was quite obvious that the perform-



ance of females was above that of the males, these differences were not statistically significant. It was possible to develop regression equations yielding estimates of achievement, which estimates were better than random guesses. The standard deviations around the regression lines were generally relatively large. Likewise, the sampling error of the regression coefficient was not so small as might be desired. Moreover, the errors of estimate for a particular value of  $X$ , and especially for a particular individual, were very large. In spite of these evidences of unreliability, the equations here reported are to be recommended in preference to subjectively derived estimates of achievement.

#### 4. INDIVIDUAL AND SMALL GROUP METHODS OF LABORATORY INSTRUCTION IN GENERAL COLLEGE CHEMISTRY.

W. Donald Clague; *Bridgewater College*.

This study was an attempt to determine the effectiveness of individual work in the laboratory as compared with working in pairs in General College Chemistry. The class was divided into two sections on the basis of class schedules, given a standardized test in General College Chemistry, taught by the method assigned, and given another standardized test in General Chemistry. Finally a teacher-constructed questionnaire was given students to determine student reaction to the methods used for instruction.

Results were tabulated for matched pairs and for sections as a whole. From the standardized tests, the outcomes were as follows: Students showed about equal improvement under both methods; students of high academic ability tended to do better working alone; students of lower ability tended to do better working with someone; students greatly preferred working with someone; both time and materials were saved by working in pairs.

On the basis of this study, variety in methods of laboratory instruction in General College Chemistry would seem desirable.

#### 5. A PROJECT IN THE COOPERATIVE PRODUCTION OF INSTRUCTIONAL GUIDES FOR TEACHERS OF SCIENCE.

John Bryant Chase, Jr.; *University of Virginia*.

The purposes of this study were: (1) to discover the desires of selected teachers of science throughout the United States for instructional guides in science; (2) to produce a sample instructional guide in science, meeting the desires of the teachers selected; and (3) to use the sample guide to help teachers produce cooperatively through classroom trial other instructional guides.

State Departments of Education in thirty-eight states suggested 324 teachers who might be interested in joining this project. Each of the 324 teachers was asked by questionnaire to recommend topics for which he would like to have instructional guides. To determine what teachers felt should be included in an instructional guide, seventeen proposed items

were listed, and teachers were asked to revise and supplement the list. One hundred and thirty-two teachers from thirty-six states responded.

After an analysis of the topics recommended for development, *Microscopic Living Things in Relation to Human Activities* was selected as the topic on which to develop a sample instructional guide. To discover the desires of science teachers in Virginia for instructional guides, 736 teachers were asked by questionnaire to indicate at least three topics for which they would like to have guides. Relying on this help a sample instructional guide on *Microscopic Living Things in Relation to Human Activities* was prepared. The sample guide was mailed to participating teachers to use in teaching this topic, and they were asked to report their ideas for improvement of the guide. With the aid of 101 Virginia teachers, four additional instructional guides have been completed: (1) *The Earth's Weather and How It Affects Us*, (2) *Heredity and Evolution*, (3) *The Nature of Matter and Chemical Energy*, and (4) *The Nature and Use of Electricity*.

6. A STUDY IN THE COOPERATIVE IMPROVEMENT OF THE QUALITY OF EDUCATIONAL EXPERIENCES IN THE LABORATORY SCHOOL OF LONGWOOD COLLEGE.

Helen R. McDowell; *Longwood College*.

The purpose of this study was to determine how the quality of the educational experience of pupils in the laboratory school of Longwood College could be improved. Related to the purpose and essential to its realization was the problem of uniting the efforts of the instructional personnel in developing a consistent philosophy that would serve as a guide in directing the experience of children.

The experimenter, who was a supervisor in the school, recognized the responsibility of offering positive leadership without imposing a program upon the staff. Procedures, at first, took the form of indirect guidance to individuals and small groups in the laboratory school. This approach was used in working with the supervising teachers, committees working on curriculum development, and student teachers.

When evidences of improved living and learning began to appear, the experimenter fostered a cooperative spirit throughout the school by initiating a way to develop a school philosophy, illustrating it with actual classroom situations.

7. AN ANALYSIS OF THE TRUE VALUE FACTOR IN THE FORMULA FOR THE CALCULATION OF THE DISTRIBUTION OF MONIES FROM THE MINIMUM EDUCATION PROGRAM FUND AND THE SALARY EQUALIZATION FUND OF THE VIRGINIA STATE DEPARTMENT OF EDUCATION WITH PARTICULAR REFERENCE TO NORTHAMPTON COUNTY.

Paul G. Watson; *Cape Charles High School*.

The purpose of this study was (1) to determine whether assessment values in the assessment ratio actually represented assessment values of

the county as a whole; (a) to apply the information in (1) above to whether errors were made in determining the true value of locally taxable wealth in Northampton County which could affect the distribution of state educational monies to the county and hence to other localities as well.

The method of procedure was a very simple descriptive approach using a comparison of assessment data compiled from the State Department of Taxation's 1950 Assessment Ratio Study for Northampton County with the actual assessed values in the county and with a 25% sample of these values.

The study revealed that (1) The assessment ratio represented 1.1% of the assessed valuation of the county and 2.4% of the items of the county. (2) The average assessed value of a piece of real estate in the assessment ratio was \$518, whereas, the actual assessed value of an average piece of real estate was \$1,132. (3) Predominantly low-valued property was utilized in the assessment ratio. A projection of the assessment values of the assessment ratio against the assessment values of the 25% sample showed 46.6% to 20% respectively in properties assessed below \$998. (4) The same type of projection as used in (3) above was made of the number of items in the assessment ratio against those of the 25% sample in the very low range of \$998 and below. The percentage was 86.2 to 67 respectively. (5) Only one piece of property was used in the assessment ratio that was valued above \$5,000. The 25% sample showed that 28.7% of the assessed valuation of the county fell in this range.

Since Northampton County expended such a small amount above the 45 cents per \$100 of true valuation necessary to participate in the Minimum Education Program Fund and the Salary Equalization Fund, and since it is accepted that high-valued property is generally assessed low and low-valued property is generally assessed high, in the opinion of the author the above listed findings are significant.

#### 8. A PRELIMINARY INVESTIGATION IN THE TEACHING OF COLLEGE BIOLOGY.

Mary H. Richardson; *Stratford College*.

This project came about because of a profound dislike of college biology textbooks which separate the zoological and botanical aspects of the study.

The purpose of this investigation was to dovetail the two kingdoms, plant and animal, so that students would acquire a total picture of the life processes of plants and animals.

One class in biology was taught by the old stereotyped, textbook method, another by this new method. In the latter, the students planned the course by choosing and outlining the areas such as, "Cells and Protoplasm", "Reproduction", etc., forming groups for study and research, planning for speakers or field trips and using visual aids. The instructor gave approval before assignments were carried out.

Results were most gratifying. Scientific thinking and procedure re-



placed the simple acquiring of facts. Interest was keener, group work made for better citizenship, research increased, desired associations were made, and much was learned.

9. CONSTRUCTION AND VALIDATION OF A SCALE FOR MEASURING ATTITUDE TOWARD MATHEMATICS AND A SCALE FOR MEASURING ATTITUDE TOWARD THE SCIENCES.

Alonzo M. Myster, Doris M. Wood, and Lillian M. Banks; *Virginia State College*.

The results of investigations designed to construct and validate a scale for measuring attitude toward mathematics and an attitude toward the sciences are reported. For both the mathematics and the science attitude scales it was possible to break the over-all attitude variable down into three components: attitude toward studying the subject, attitude toward a vocation in the field, and general attitude. The coefficients of reliability for the S-, G-, and V-scales of the mathematics attitude variable were, respectively, .8902, .9071, and .9933. For the science attitude scale utilizing the sigma method scoring the coefficients of reliability for the S-, G-, and V-scales were .745, .592, .928, respectively. For the sigma method of scoring these values were .918, .765, and .910, respectively.

In the case of the mathematics attitude scale it was shown that the scale differential between groups of individuals whose attitude should logically differ on an average. In the case of the science attitude scale it was shown that the sigma method of scoring, except in the case of the G-scale, yielded estimates of reliability differing from those obtained when the five-point method of scoring was used. Both the science attitude scale and the mathematics attitude scale provided convincing evidence that the S-, G-, and V-scales have different population coefficients of reliability.

The attitude scales here reported are of sufficient reliability to justify their use in actual classroom practice for practical purposes of teaching and guidance. In actual practice it is to be borne in mind that attitude toward studying, attitude toward vocations, and general attitude will not be estimated with equal reliability. Notwithstanding this fact the scales here reported are to be recommended over more subjective techniques or procedures of attitude evaluation.

PANEL DISCUSSION

THE MANPOWER SHORTAGE IN THE SCIENTIFIC FIELDS AND THE IMPLICATIONS FOR SCIENCE EDUCATION IN THE PUBLIC SCHOOLS.

Jack H. Boger, *Richmond Public Schools*;

J. W. Cole, *University of Virginia*;

Alfred L. Wingo, *State Department of Education*;

Alex Sadle, *Allied Chemical and Dye Corporation, Hopewell*.

## BUSIENSS MEETING

The report of the nominating committee was presented and the following officers were elected by the Section of Education to serve for the year 1955-1956: *Chairman*, DeForest L. Strunk, II; *Secretary*, W. Donald Clague.

## MINUTES OF THE SECTION OF ENGINEERING [7]

PHILLIP L. MELVILLE, *Chairman*

DUDLEY THOMPSON, *Secretary*

ROBERT M. HUBBARD, *Section Editor*

FRIDAY, MAY 13 AND SATURDAY, MAY 14 — 9:00 A.M. —  
ROOM 201, BURRUSS SCIENCE HALL

### 1. INVESTIGATION OF SLOTTED AND PERFORATED TRANSONIC NOZZLES.

Robert W. Truitt and Arthur C. Bruce; *Virginia Polytechnic Institute.*

A comparison is made of solid and open tunnel working sections. In closed and open tunnels it is shown that wall corrections are required for angle of attack and drag coefficient. In solid wall supersonic tunnels an undesirable characteristic is the reflection of shock waves. In the transonic range a phenomenon known as "choking" occurs in solid wall tunnels and prevents testing in the neighborhood of  $M_0 = 1$ .

To overcome these undesirable characteristics of solid and open tunnels, partially open tunnels were designed and constructed by employing slots or perforations. They have the ability to make the wall corrections for subsonic flow equal to zero, to give noticeable shock and expansion wave cancellation, and to allow testing in the neighborhood of  $M_0 = 1$ .

Mach number distributions which were obtained with the V. P. I. slotted and perforated nozzles indicated that the slotted nozzle gave better distributions. The distributions in both nozzles became less satisfactory as the speed increased. Observations of flow about wedges in each nozzle indicated that the perforated nozzle gave better wave cancellations. It is concluded that the V. P. I. slotted tunnel is more advantageous for subsonic flow and the perforated nozzle for supersonic flow.

### 2. A NEW METHOD OF ACCIDENT ANALYSIS AND ITS APPLICATION TO HIGHWAY ENGINEERING.

Alfred Vick, III; *Virginia Department of Highways.*

The Highway Department has an accumulation of traffic accident information in the accident records which is filed by the individual drivers involved, and the investigating officers of the vehicle accidents occurring in Virginia. An Accident Analysis System was recently established by the Highway Department in order to provide information to serve as a basis for recommendations for correcting deficiencies on existing highways and to aid in the sound design of new highways. Several brief examples are given of field investigations made at accident prone locations and other special accident studies, all of which make use of the Accident Analysis System.



## 3. LET'S TAKE THE "BURGERS" OUT OF CONTROL SYSTEMS.

B. A. Niemeier; *Consulting Engineer, Richmond.*

Problems encountered and generally apparent as a result of the lack of understanding in the general field of controls are reviewed. In language for the layman and using a series of colloquialisms an attempt is made to educate the professional and subprofessional toward a more basic understanding of controls. From an engineering point of view all controls are categorically examined from the safety or convenience aspect.

## 4. MODEL STUDIES OF PRESTRESSED CONCRETE BEAMS USED IN THE HAMPTON ROADS APPROACH BRIDGES.

Ignacio Romero; *Virginia Council of Highway Investigation and Research.*

There are cases in engineering where the mathematical solution of certain structural forms becomes too extensive and involved to be of practical use, or where verification of the accuracy of analytical solutions by means of tests is required. In either case the use of models could be of great help to obtain the desired information.

The Virginia Council of Highway Investigation and Research is conducting an investigation of model studies of prestressed concrete beams used in the Hampton Roads approach bridges. A 50-foot span stringer was chosen as prototype, and models were constructed to scales of 0.1, 0.2, and 0.3.

The data indicate that prestressed concrete models exhibit a generally true behavior within the elastic limit. Values outside of the elastic range show a tendency in the models to increase in strength with the reduction of the scale factor, a fact that has also been established in previous investigations with plain and reinforced concrete. After the completion of this study, it may be possible to find out whether model analysis is feasible outside of the elastic limit of the stresses.

## 5. A STUDY OF HIGHWAY SIGN LEGIBILITY

Terrence M. Allen; *Virginia Council of Highway Investigation and Research.*

The use of reflectorized materials has greatly increased the night legibility of highway signs. However, these materials have raised new problems. Materials differ greatly in reflectance characteristics and cost, and there is need for basic information on the relationships between sign reflectance and legibility under night highway conditions.

A field experiment with one specific type of sign is reported. The complexity of results indicated need for laboratory study, with each of the important factors controlled experimentally. A laboratory experiment involved four factors: sign brightness, surrounding illumination, letter series, and contrast direction. Statistical analysis showed interaction between brightness and the other factors. Curves are presented showing results for each factor. The phenomenon of irradiation and its relation

to highway signs is discussed. Effects of opposing headlight glare were studied, and found to be very different for different levels of sign brightness.

The general relationship of brightness and legibility is used to illustrate the way in which design criteria for reflectorized signs will be developed.

6. SCHLIEREN PHOTOGRAPHY, HIGH BRILLIANCE LIGHT SOURCE.

Orville R. Harris; *University of Virginia*.

A high brilliance, high frequency light source has been developed for use in Schlieren air flow photography. A peak brilliance of up to 174 million candles per square inch and an average brilliance of up to 62 million candles per square inch over a ten microsecond period has been obtained. The repetition rate is continuously variable from 10 to 5000 cycles per second provided the maximum power input does not exceed one kilowatt at the highest frequency, and this repetition rate can be synchronized to the impulse generator output of a motion picture camera.

7. THEORY OF FREE STREAMLINES IN COMPRESSIBLE FLOW.

Robert W. Truitt; *Virginia Polytechnic Institute*.

The modified Lorentz transformation of the Sound-Space Theory is used to derive a relation between compressible and incompressible free-streamlines. It is shown that an exact solution of the Sound-Space coordinate transformation is possible for the case of free streamlines in compressible flow.

The general expression is applied to several examples of free streamline flow from classical hydrodynamic theory. A simplified analysis is given for the establishment of two-dimensional low supersonic flow in a slotted transonic-type working section. The amount of slot opening for an effective minimum-length nozzle is found to be a function only of design Mach number.

8. A STUDY OF VARIABLES AFFECTING CHEMICAL CONTROL OF SHRUBS ON POWER LINE RIGHT-OF-WAYS IN SOUTHWEST VIRGINIA.

Herbert P. Olson and Frank C. Vilbrandt; *Virginia Polytechnic Institute*.

Variables affecting the chemical control of shrubs were studied on selected plots on Appalachian Power Line right-of-ways. The investigation was limited to the Roanoke area, and the specific shrubs studied were locust, sumac, and ailanthus. The variables studied were time of spraying, herbicides used, quantity of herbicides, spraying method, rainfall, terrain, exposure, climate, age of shrub, and virility of shrub. Observations were made on the commercial herbicide applications performed by the Bartlett Tree Expert Company in 1951, 1952, and 1953.

The effect of each variable could not be determined effectively because of the short time association with the project. The dominating variables

are time of spraying, rainfall, quantity and type of herbicides used, and virility of shrub.

Further investigation should be continued for the next three years. These investigations should include replications wherever possible, with statistical implications.

A colored pictorial record of the eight test plots was obtained for November, 1954, and April, 1955.

#### 9. CALCULATION OF INDIVIDUAL, MASS-TRANSFER COEFFICIENTS FOR TWO-PHASE, LIQUID EXTRACTION SYSTEMS.

John E. Lastovica and Nelson F. Murphy; *Virginia Polytechnic Institute*.

A method is presented for calculating interfacial concentrations and film mass-transfer coefficients for liquid extraction systems. Using the ternary phase diagram, a graphical solution is presented. The same solution can be made algebraically using the distribution curve and the equations obtained from material balances:

$$C_{wi} = \frac{(L_{w2} C_{w2} + L_{s2} C_{s2})}{L_{w2} + \frac{L_{s2}}{m}} = \frac{(L_{w1} C_{w1} + L_{s1} C_{s1})}{(L_{w1} - N) + \frac{(L_{s1} + N)}{m}}$$

$$C_{si} = \frac{C_{wi}}{m}$$

where:

C = solute concentration, lb./cu. ft.

N = rate of mass transfer, taken as positive when solute is

m = distribution coefficient

L = phase flow rate, cu. ft./hr.

subscripts:

wi and si = reference to the water and solvent side of an interface, respectively

w1 and w2 = reference to inlet and outlet water streams of an extractor, respectively

s1 and s2 = reference to inlet and outlet solvent streams of an extractor, respectively

Film coefficients, calculated by this method, can be converted into overall coefficients. These were shown to agree with published values regardless of extractor design.



# 10. CHARACTERISTICS OF SIEVE PLATES FOR CONTACTING LIQUID AND VAPOR.

James I. Lankford; *University of Virginia*.

Capacity data have been developed for use in industrial sieve-plate columns. Water and air were used in a transparent plastic column 12 inches square having plates 6" by 12" by  $\frac{1}{4}$ " thick. The holes varied from  $\frac{1}{32}$ " to  $\frac{1}{4}$ " in diameter. The variables measured included pressure drop, weepage point, froth height, and entrainment level, all measured at various air mass velocities, liquid rates, and liquid depths.

For small holes pressure drop increased as air rate increased; for larger holes pressure drop passed through a minimum before increasing. Froth height was relatively constant. Entrainment increased rapidly at high air rates.

# 11. INDIVIDUAL DYNODE VOLTAGE REGULATOR FOR PHOTO-MULTIPLIER TUBES.

Bruce d'E. Flagge and Orville R. Harris; *University of Virginia*.

Extensive use of multiplier phototubes in scintillation counters, suspension systems, and photometers, in recent years, has increasingly emphasized the need for good stabilization of the individual dynode voltages. This voltage stabilization would stabilize phototube gain. Gain stability has been attempted, with various degrees of success, with regulated power supplies and batteries, but it is only recently that much has been done to regulate the individual voltages between dynodes. High voltage multiplier phototube operation has been reported by Stump and Talley in *Rev. Sci. Inst.*, p. 1132, Nov. 1954. This was accomplished by the regulation of the last two dynode potentials by VR tubes, but regulation of all dynodes in this manner necessarily results in rather cumbersome equipment and a multi-conductor cable. The latter, due to the relatively high voltages, is subject to problems of current leakage and voltage breakdown between cable conductors.

These problems have been eliminated by the development of an individual dynode regulating system which can be mounted on the phototube socket in much the same manner as, and with no more difficulty than, the common bleeder resistance voltage divider. The report is organized to explain the operation and design of this system.

# 12. CAUSES OF HIGHWAY SIGN FAILURE.

Arthur L. Straub; *Virginia Council of Highway Investigation and Research*.

A questionnaire survey was conducted to gather information on sign replacements in Virginia. Data (age at replacement, height, location, message, cause of replacement, etc.) were secured on 3,500 signs (a 6% sample). Overall age at replacement was 34.3 months. Natural weathering accounted for 40.7% of replacements at an average age of 44.3

months; vandalism, 32.5% at 32.1 months; change in policy or law, 19.3% at 25.0 months; vehicle damage, 7.5% at 24.5 months. Based on natural failure, costs attributable to lost life were: vandalism, \$72,500 per year (11.7% of total sign costs); change in policy or law, \$67,500 (10.9%); vehicle damage, \$27,000 (4.4%). The data did not justify recommendations to change sign locations to reduce natural failure or vehicle damage. Gunshot damage was prevalent during hunting season. Signs near schools or school bus stops were three times as likely to be marked up as those near other public places. The probability of a sign being marked up was three times greater if it were within six feet of the ground. Therefore, this type of damage could probably be reduced if only signs near schools and school bus stops were raised. Other significant relationships were cited and recommendations made.

13. AN INVESTIGATION OF THE PROPERTIES OF VARIOUS GRADATIONS MEETING F-1, SAND-ASPHALT, SPECIFICATIONS.

Philip E. McIntyre; *Virginia Council of Highway Investigation and Research.*

Virginia sand asphalt pavements are fairly short lived and the durability of these pavements is much less than asphaltic concrete. The short life is attributed to rapid oxidation of the asphalt which is permitted by the high void content of the mixture. Therefore, this study was proposed to investigate the properties of various gradations meeting Virginia's F-1, sand-asphalt, specifications, and to correlate these properties with the gradations in an attempt to locate the most desirable gradings from the standpoint of good stability and low air void content.

Using three basic grading groups and allowing only one extremity of each curve to vary at a time, a total of thirteen gradings was designed.

The Marshall test method was used throughout the study, however; particular emphasis was given only to the stability and per cent voids-total-mix figures.

The most important results can be summarized as follows: (1) an increase in top size material produced an increase in stability; (2) an increase in top size material produced a decrease in voids; (3) an increase in filler produced an increase in stability; (4) an increase in filler produced a decrease in voids; and (5) an increase in filler produced a decrease in the asphalt demand.

14. DESIGN AND CONSTRUCTION OF AN ULTRASONIC SYSTEM FOR STUDY OF LIQUID-LIQUID EXTRACTION.

Hughey A. Woodle, Jr. and Dudley Thompson; *Virginia Polytechnic Institute.*

Possible application of ultrasonic energy to unit operations has interested various chemical engineers for several years. A laboratory size pilot plant has been designed and constructed to facilitate study of effect of ultrasonic energy on mass transfer in liquid-liquid extraction. Ultra-

sonic equipment is a Brush Hypersonic generator of 250 watts rated output used in conjunction with bowl-shaped barium titanate piezoelectric crystal of approximately 400 kilocycles per second frequency. A single contact cell contactor for two liquid phases has been designed to utilize focused ultrasonic waves issuing from barium titanate element. Overall equipment will handle continuous flow of most two-phase, multiple component liquid systems with flow rates for each phase ranging up to one half gallon per minute and could be used for ultrasonic studies of two-phase liquid systems in several unit operations other than mass transfer and liquid-liquid extraction by design and attachment of particular type reaction chamber desired. Instrumentation for use in economic study of power used in ultrasonic treatment of the liquid system is an integral part of the apparatus. First liquid system to be studied using pilot plant will be acetone-water-1, 1, 2-trichloroethane.

#### 15. USE OF PRESTRESSED CONCRETE IN THE HAMPTON ROADS BRIDGE TUNNEL PROJECT.

J. N. Clary; *Virginia Department of Highways.*

Prestressed concrete provides a material that will be free of tensile cracks and should be less subject to deterioration from water. Because of this property as well as for economy in construction, prestressed concrete has been chosen for use in the trestle bridge approaches to the Hampton Roads Tunnel.

There are to be a total of 189 spans each 50 feet long; 65 spans are in the north approach and 124 are in the south approach. All spans will be supported on concrete pile bents. All bents in the north approach trestle and 64 bents in the south trestle will contain four 24" square pre-cast, prestressed, pretensioned concrete piles each. These are prestressed using 32 cables of 3/8" diameter. The remaining 59 bents have 2 piles each. These will be 54" diameter cylindrical concrete piles centrifugally cast in sections 16 feet long. These sections are later joined end to end and prestressed by post-tensioning and grouting-in the prestressing cables.

It is believed that the use of prestressed concrete in these structural members will provide maximum service life in this location where they will be exposed to the action of salt water.

#### BUSINESS MEETING

The chairman convened the business meeting at 4:10 P.M. on Friday, May 13. The previously appointed nominating committee consisting of R. W. Truitt, B. A. Niemeier, and R. M. Hubbard presented the following two names on a slate of officers for the year 1955-1956, who were unanimously elected to serve:

*Chairman, Dudley Thompson*

*Secretary, David Michael Crim.*

A report of the Section Editor was heard. After discussion of the method



of preparing the scroll for the George Washington Engineering Award, it was decided to prepare printed sheets for use in the next few years. The possibility of having special meeting sponsored by the Engineering Section at other times than the annual meeting was discussed, and Mr. Melville was instructed to mention the desires of the Section to members of the Council of the Academy. From four contestants describing their exhibits, Mr. William Conde of the Huntington High School, Newport News, Va. was selected to receive the 1955 George Washington Engineering Award. The business meeting then adjourned.

16. A STUDY OF BOND BETWEEN PRETENSION STEEL AND CONCRETE IN PRESTRESSED CONCRETE.

Charles E. Echols; *Virginia Council of Highway Investigation and Research.*

A novel testing procedure was devised by which loads were applied to either end of a collapsible metal box cast in the center of the experimental concrete beam containing a single pretensioning unit. Test loads compressed the concrete with greater force than offered by the opposing strain on the wire and at this point bond between wire and concrete failed.

Tests with 0.146 inch diameter smooth wire showed that adhesive bond is effective only over a length of embedment of about 18 inches when concrete compressive strength is 6000 psi. Bonding qualities for this smooth wire improved when the pretension rose above 90,000 psi. In the pretension transfer range of 75,000 to 125,000 psi, concrete compressive strengths under 4500 psi could not be depended upon to develop adhesive bond for the smooth wire.

A comparative study of 5/16 inch diameter stranded wire pretensioning units composed of six 0.100 inch diameter smooth wires wrapped around a 0.108 inch diameter smooth wire revealed that the critical concrete compressive strength for developing adhesive bond was about 3500 psi. Dimpled wire appeared to have bonding ability 33 1/3 per cent in excess of that developed by stranded wire.

17. AN ANALYTICAL METHOD FOR ANALYZING HIPPED PLATE STRUCTURES.

Daniel Frederick; *Virginia Polytechnic Institute.*

Using the classical theory for the bending and extension of plates, solutions for each plate of the structure are written in series form. The boundary conditions at all edges not at a fold are taken into account in the usual manner. At each fold, the displacements and stresses must be continuous. This permits the writing of the proper number of equations to evaluate all of the constants. However, contrary to existing proposed solutions, the extension of one plate contributes to the bending of the other and vice versa. It is assumed that the effects of the bending and extension can be added linearly.

## 18. ATOMIC EXPLOSIONS AND STRUCTURAL STABILITY.

Henry L. Kinnier; *University of Virginia*.

As a result of the first atomic explosions in August, 1945, and the fast pace at which the atomic scientists of the world have developed larger and more destructive nuclear bombs, the structural engineering profession has found itself faced with the difficult, if not impossible, task of designing and building structures that can resist the terrific effects of these explosions.

It was soon recognized that complete and unqualified "blast-proof" design and construction was impossible; it was also realized that there were many design features and methods of construction that would prevent complete or even partial collapse of a structure under severe conditions. The most important of these structural features are thought to be: (1) continuity in design, that is, the use of continuous reinforced concrete frames or welded steel frames with stout moment resisting joints; (2) utilization of appropriate building materials; (3) the prudent use of geometrical shapes.

Blast resistant construction is, of course, more expensive than the conventional industrial building construction that is generally used in the United States today but not prohibitively so. The increase in cost will depend upon many variable factors that would be set up in the design specifications.

## 19. INVESTIGATION OF WEDGES AT ANGLE OF ATTACK.

Robert W. Truitt and Robert D. Jones; *Virginia Polytechnic Institute*.

A series of wind tunnel tests was run on three symmetric diamond wedges ( $5^\circ$ ,  $7\frac{1}{2}^\circ$ , and  $10^\circ$ ) to determine the pressure distributions. The pressure distributions were integrated to find the lift and pressure drag coefficients for a series of angles of attack. The results are compared with theory and other high speed experimental results.

## 20. A SEMI-INSTANTANEOUS RAINFALL RATEMETER.

Leo F. Goeller; *University of Virginia*.

Rain gauges in general consist of a cylindrical collector and a weighing or volume measuring system. The Universal Recording Rain Gauge delivers collected rainfall to a tipping bucket mechanism which records on a clockwork-driven recording drum. At rainfall rates of one millimeter per hour the bucket tips at about fifteen minute intervals. The rain gauge described records accurately at fifteen second intervals rainfall rates as low as one millimeter per hour. The output of a number of collectors may be combined electrically in the integrator described to give an accurate average rainfall for any specific area at fifteen second intervals. The instrument may also be used as a rainfall totalizer not susceptible to evaporation losses at low rainfall rates.

21. THE DESIGN OF A PILOT PLANT FOR THE PRODUCTION OF MALEIC ACID HYDRAZIDE.

Willard H. Sawyer and Frank C. Vilbrandt; *Virginia Polytechnic Institute*.

Maleic acid hydrazide is a plant hormone which will reduce the growth of the plant, but will not cause plant or soil sterility. This characteristic makes maleic acid hydrazide useful as a herbicide. The purpose of this investigation was to determine the optimum synthesis method and conditions, to analyze cost, and to design a pilot plant for the production of maleic acid hydrazide.

It was concluded from this investigation that the optimum synthesis method and conditions were: (1) five minutes for the reaction time, (2) a stoichiometric quantity of 85 per cent hydrazine hydrate, and (3) a 10 per cent excess of the stoichiometric quantity of maleic anhydride; the reaction occurred at 85° F., with the hydrazine hydrate dissolved in 95 per cent ethyl alcohol; the ethyl alcohol constituted 73 weight per cent of the reaction mass. A 26 per cent of the theoretical yield was obtained.

The pilot plant was designed to produce 10 pounds of purified maleic acid hydrazide per day. With a competitive selling price of \$4.38 per pound, the total fixed plus working capital must be \$129,377. A research subsidy of \$96,000 a year was required to produce a 10.3 per cent return on the investment.

22. CORRELATION OF SOIL PROPERTIES AND INDEX CONSTANTS.

C. Page Fisher and William H. Vogelsang; *Froehling and Robertson, Inc., Richmond*.

The results of about sixty-five laboratory analyses of undisturbed samples from the Norfolk, Virginia, area are examined. A brief description of the general geology of the area is given. The sampling and laboratory testing techniques and equipment are described. The soils are described as stratified sands, silts, and clays in a complex arrangement with a large but variable organic content. Much of the organic material was in a good state of preservation.

The data indicate little or no correlation between the Standard Penetration Test and laboratory shear strengths, but do show that the consolidation characteristics may be estimated from the Atterberg Limits.



## MINUTES OF THE SECTION OF GEOLOGY [8]

WILLIAM T. HARNSBERGER, *Chairman*

WILLIAM T. PARROTT, *Vice-Chairman*

MARCELLUS H. STOW, *Secretary*

W. D. LOWRY, *Section Editor*

FRIDAY, MAY 13, 1955 — 9:00 A.M. — ROOM 209, BURRUSS  
SCIENCE HALL.

1. WAS THERE A "FALL-OUT" OF RADIOACTIVE MATERIAL IN LEXINGTON, VIRGINIA IN MAY 1954?

Marcellus H. Stow; *Washington and Lee University.*

Normal background radioactivity in Lexington, Virginia, is 0.025 MR/HR. On May 13, 1954, the weather was clear in the morning and cloudy in the afternoon. During the morning a scintillation counter indicated normal background radioactivity; in the afternoon it indicated 0.25 MR/HR, or 10 times normal. The next day, May 14, there was a heavy rain all day; in the morning 0.4 MR/HR was registered and in the afternoon 0.25 MR/HR. The third day, May 15, was cloudy with light showers and the counter read 0.25 MR/HR in the morning. On May 16, there was light rain in the early morning; no instrument readings were taken that day. The weather on May 17 was clear and the scintillation counter indicated 0.2 MR/HR in the morning and normal background of 0.025 MR/HR at 4:30 P.M. On the 18th there was rain until mid-day and clouds in the afternoon, but normal radioactivity continued. All readings referred to were the same indoors and out.

The maximum anomalous radioactivity of 0.4 MR/HR, noted on May 14, was 16 times normal radiation for the area. Since the above dates, no anomalous radioactivity has been detected. Specific cause of this phenomenon is not known, but "fall-out" of radioactive material may be presumed.

2. THE EFFECT OF TRAFFIC POLISHING ON LIMESTONE AGGREGATES.

W. T. Parrott; *Virginia Department of Highways.*

This paper deals with the effect of limestone aggregates on skid resistance. A review of the various types of aggregates which have been used and certain tests are presented.

A theory is presented to explain the poor skid resistance of limestone aggregates. Water is believed to find its way between calcite crystals developed on the larger fragments of the aggregate to form an effective plane of lubrication which gives rise to skidding when the brakes of a car are applied suddenly.

In this paper it is recommended that limestones not be ruled out but that their skid resistance be improved by the addition of silica, sand, slag, or rock asphalt.

### 3. THE BERGTON-CRAB RUN GAS FIELD, WESTERN ROCKINGHAM COUNTY, VIRGINIA.

R. S. Young and W. T. Harnsberger; *Virginia Division of Geology*.

Recent drilling on the Bergton-Crab Run anticline, western Rockingham County, Virginia, has partly delimited a small, potential gas field. This field is in the folded Appalachians, about 25 miles southeast of the Appalachian structural front, where the carbon ratio is in excess of 80.

Rocks of the Bergton district range in age from Upper Ordovician to Lower Mississippian. The "Oriskany" sandstone of Devonian age is the major pay zone with minor showings in overlying shales. Along the axial part of the Bergton-Crab Run anticline the "Oriskany" is encountered in wells at a depth of approximately 3,000 feet.

Major structural elements of the area are complex folds; no mappable faults were recognized in the area west of the North Mountain fault, which lies about 11 miles southeast of the Bergton-Crab Run anticlinal axis. The gas-bearing structure is complicated by several minor folds, most of which parallel the major axis. Though limited in extent northeast of Bergton, the anticline appears to be continuous with a large anticlinal complex 25 miles southwest. Local doming along the axis should present favorable areas for future exploration.

### 4. MONAZITE DEPOSITS IN VIRGINIA.

Charles E. Sears, Jr.; *Virginia Polytechnic Institute*.

Monazite, a phosphate of rare earths, is the principal source of thorium. This element has increased in importance and it also has possibilities of being a source material for  $U^{233}$  which can be produced from thorium in breeder reactors. Monazite occurs in two belts in the Virginia Piedmont; the western belt extends from Stuart in Patrick County to Fredericksburg, Virginia; the eastern belt extends from Bracey in Mecklenburg County to west of Richmond where it joins the western belt. In the Blue Ridge province, monazite is found in Lower Cambrian sandstones at several localities. The age of these deposits, their origin, and economic value are discussed.

### 5. CURRENT MANGANESE OPERATIONS IN VIRGINIA.

E. O. Gooch; *Virginia Division of Geology*.

Manganese production in Virginia began in 1834, although little was produced before 1867. Virginia produced manganese annually from 1867 until 1946 when production from mines ceased.

The United States normally imports most of its manganese. With the unsettled international situation of 1950 and the possibility of the

foreign supply being cut off in the event of a world conflict, the government began a stockpiling program for domestic manganese. Under this program, the government contracts to buy, at set prices, specified amounts of manganese meeting certain chemical and physical requirements. This program led to the revival of manganese mining in Virginia and, under the impetus of government support prices and modern mining and milling practices, there has been an annual increase in production.

The three principal manganese districts in Virginia are: (1) the James River-Roanoke River district in Campbell and Appomattox counties; (2) the western base of the Blue Ridge from Front Royal southwestward to the Tennessee state line; and (3) the Valley Ridges section of western Virginia from Frederick County to Lee County. Although there is current production from all three districts, the greatest production has been from the latter two in the southwestern part of the State.

6. THE ORIGIN OF A GREENSTONE CONGLOMERATE IN THE VICINITY OF CHARLOTTESVILLE, VIRGINIA.

Robert M. Cordova; *University of Virginia*.

Along the southeastern slopes of the Southwestern Mountains in Albemarle County, Virginia, there crops out a rock which during reconnaissance was classified as a volcanic conglomerate. The "conglomerate" is a mappable unit (maximum thickness 1300 feet) within a thick series of Upper Pre-Cambrian or Lower Cambrian metabasaltic (hornblendic greenstone) flow sheets known as the Catoctin greenstone. The "conglomerate" is distinguished readily from the metabasalt because it has a nodular surface. The nodules, which are greenstone, protrude from a schistose matrix; they appear to be the surface of pebbles, cobbles, and boulders.

A detailed study discloses that the composition of the "conglomeratic" materials is very uniform. There is essentially only one compositional, textural, and structural variety of coarse constituent. There is also a high degree of rounding with no apparent sorting.

These characteristics are not readily explained as a result of stream action, wave action, glacial erosion, mud-flow (lahars) transport, or kata-morphism. It is concluded that the greenstone conglomerate is the result of a complex interlacing of joint sets and that the rounding was produced by attrition along the joint planes during intense orogeny.

7. A MICA PERIDOTITE DIKE NEAR FRONT ROYAL, VIRGINIA.\*

Robert S. Young and Roy A. Bailey; *Virginia Division of Geology and U. S. Geological Survey*.

A mica peridotite dike occurs 2.8 miles S. 11° E. of Waterlick, Virginia, in the Strasburg quadrangle. It intrudes the east limb of the Massanutten syncline and is enclosed in the Martinsburg shale of Ordovician age. The dike is apparently conformable with enclosing beds which strike N. 28° E. and dip 65° E. It is about 6 feet wide and is exposed for approxi-

\* Publication authorized by the Director, U. S. Geological Survey, and the State Geologist Virginia Division of Geology.



mately 600 feet in prospect pits. The shale contacts are brecciated and hardened for about a foot by mild thermal metamorphism.

The mica peridotite is composed of chlorite, 43 per cent; phlogopite, 31 per cent; hydrobiotite(?) pseudomorphous after phenocrysts of olivine and pyroxene, 13 per cent; secondary pyrite, 5 per cent; perovskite partly altered to leucoxene, 4 per cent; apatite, 2 per cent; dolomite, 1 percent; and ilmenite, magnetite and epidote, < 1 per cent. In thin section, the rock consists of altered olivine and pyroxene phenocrysts in a matrix of coarse crystals of phlogopite and fine-grained interstitial chlorite. Relatively large apatite crystals are poikilitically included within phlogopite and also in interstitial chlorite. The petrographic similarity between this rock and the mica peridotite and alnoite dikes in Kentucky, Pennsylvania, and central New York suggests that they may be related, but definite correlation cannot be made.

#### 8. ARE THE DEPRESSIONS OF MAJOR FOLDS OF THE VALLEY AND RIDGE PROVINCE OF VIRGINIA OF DEPOSITIONAL ORIGIN?

W. D. Lowry; *Virginia Polytechnic Institute.*

Culminations of major folds of the Valley and Ridge Province are not merely quirks of fate. In numerous places two or more adjacent folds plunge in the same direction and their structurally highest parts are contiguous. Could the depressions of major synclines, as well as anticlines, result from accumulation of greater thicknesses of land-derived clastic sediments adjacent to major contributing streams? Once depressed isostatically, such areas never recover from their initial disadvantage and even may be downwarped further while adjacent areas in the same strike belt are upwarped.

The thickness of the section in Massanutten Mountain, the depression of the great Massanutten syncline, may be 2000 feet greater than that near Endless Caverns. The extra thickness may be the result of concealed repetition, but evidence suggests it is real.

The broad Kimberling basin of Bland County between the Burkes Garden and Bane domes contains an abnormally thick Devonian section. Perhaps the depositional floor of the basin was sufficiently depressed so that when deformed later, it buckled downward whereas adjacent areas buckled upward into major anticlines.

Additional measurements may prove either depositional control of depressions or contemporaneous longitudinal warping. Such findings would facilitate the search for many nonmetallics including oil and gas.

#### 9. A VIRGINIA OCCURRENCE OF PALIGORSKITE.

Troy J. Laswell and Marcellus H. Stow; *Washington and Lee University.*

In 1953 D. E. Brady, Jr. collected specimens of a soft, tough, white, fibrous mineral from cleavage planes and slickensided surfaces in Lower Cambrian Shady dolomite of the Lone Jack quarry near Glasgow, Rock-

bridge County, Virginia. Additional specimens were collected by the authors in the spring of 1955.

The mineral was subjected to blowpipe and qualitative chemical analyses by Laswell and found to be a hydrous magnesium-aluminum silicate with a small amount of calcium.

A specimen submitted to the Petrographic Laboratory of the U. S. Geological Survey was analyzed chemically, optically, and by x-ray diffraction by Jewell Glass and Fred Hildebrand. Miss Glass reports that the mineral has a mean index of refraction of 1.52 and that the mineral is a "hydrous Al-Mg-silicate, close to Paligorskite". X-ray diffraction patterns also indicate paligorskite.

Paligorskite, an aluminous amphibole, was first described by T. v. Savchenkov (Vh. Min. Ges., p. 102, 1862). The chemical analysis of paligorskite is given by Dana as:  $\text{SiO}_2$ , 52.18 percent;  $\text{Al}_2\text{O}_3$ , 18.32 percent;  $\text{MgO}$ , 8.19 percent;  $\text{CaO}$ , 0.59 percent;  $\text{H}_2\text{O}$ , 12.04 percent; hygroscopic water, 8.46 percent (total 99.78 percent).

In so far as the writers are aware, this Rockbridge County occurrence of what appears to be paligorskite is the first recorded in Virginia.

#### 10. WHAT IS THE TRUE SIGNIFICANCE OF THE ROCKFISH CONGLOMERATE?

R. V. Dietrich; *Virginia Polytechnic Institute*.

Rocks in Albemarle, Amherst, Bedford, and Nelson counties, Virginia, previously identified as Rockfish conglomerate, have been alleged to constitute a basal conglomerate of the Lynchburg formation. Recent examination of many outcrops shows that the metaconglomerates occur as lenticular masses at several stratigraphic horizons within rocks previously mapped as Lynchburg formation and as Lovingston gneiss.

Observed imbrication of fragments in this polymictic metaconglomerate indicates a northeastern or southwestern source for the fragments; both possibilities must be considered until correct top and bottom determinations are made.

Statements that some fragments within the metaconglomerate are of higher metamorphic rank than that of the matrix have not been substantiated. At least some fragments have had their foliation developed since they were incorporated in the conglomerate; foliation within lath-shaped fragments whose long axes lie athwart the foliation of the matrix is parallel to foliation of the matrix itself.

It is suggested that evidence relating to the hypothesis that the Rockfish metaconglomerate constitutes the basal part of the Lynchburg formation and to the idea that the metaconglomerate constitutes unequivocal evidence for a "profound unconformity" between the Lynchburg formation and an "older Precambrian injection complex" should be re-examined objectively. Observations appear to suggest that at least some of the rocks previously mapped as Rockfish conglomerate are intraformational lenses and that at least part of the "injection complex" of some previous workers is a metasedimentite conformable with the Lynchburg formation.

## 11. GROUND WATER IN THE WAYNESBORO, VIRGINIA AREA.

Jack Lowdon; *University of Virginia*.

In the southeast environs of Waynesboro, Virginia, large quantities of relatively soft water have been recovered from the Tomstown dolomite for a number of years by means of deep wells. There is an unusual relationship between these wells and a large spring in the area. This spring is unaffected by pumping a well adjacent to it, but its flow is diminished appreciably by heavy pumping of a well field 3,000 feet away. Although the spring occurs in a shale formation known to furnish hard water, it produces soft water at the rate of 5,000 gallons of water per minute. Ground water recovered from the Tomstown dolomite in this area is relatively soft. The surrounding recharge area is obviously too small to account for the known supply.

It is theorized that a large fault zone acts as an underground conduit to supply the spring and that the wells are drilled into a large system of caverns, some partially connected with the fault plane. The cavernous nature of the Tomstown dolomite coupled with a factor of time, combine to suggest this theory which satisfactorily accounts for the relationship of the wells to the spring.

## 12. PRELIMINARY INVESTIGATION OF FOSSILS IN THE ARVONIA SLATE.

Shelton P. Applegate; *University of Virginia*.

Fossils in the Arvonian slate are now known to be present in quarries of the LeSueur-Richmond Slate Co., Arvonian-Buckingham Slate Co., Williams Slate Co., and also in the Pitts' and "baseball" quarries. All of these quarries are in the same strike belt. The fossil bed as exposed in the "baseball" quarry is more than 200 feet thick.

The so-called *Buthotrephis* is most abundant, *Cornulites* is next most abundant, and crinoid remains rank third. Straight cephalopods and a gastropod are reported for the first time.

Some of the past fossil identifications are based on insufficient evidence, and a review of age determination should be made with the use of the new material now available at the "baseball" quarry.

## 13. NATURAL CHIMNEYS OF AUGUSTA COUNTY, VIRGINIA.

C. C. Fisher; *Virginia Division of Geology*.

The Natural Chimneys, located one mile north of Mt. Solon, Augusta County, Virginia, are unusually well developed erosion outliers in Elbrook dolomite (Cambrian). The flat-lying dolomite is here cut by several sets of vertical joints. Weathering along these joints has separated the chimneys from the hill behind them. Because of the attitude of the joints and the action of nearby North River in removing such debris as has fallen from the chimneys in the past, the towers rise perpendicularly above the level flood plain. Development and preservation of the chimney form have been aided by the horizontal bedding of the Elbrook. The



largest tower, more than 100 feet high, leans noticeably, as the joints bounding it are not quite vertical. The towers are not capped by resistant material, but individual towers are relatively unjointed.

Historic accounts indicate that less than 100 years ago the chimneys rose directly from a stream. Today the nearest stream is more than 100 yards away. This is one of very few measurements on the rate of lateral migration of streams.

Peculiarities of Elbrook sedimentation are described. The effects of the 1949 flood are noted.

14. MINERALOGICAL STUDIES OF SEDIMENTS FROM THE EASTERN SHORE PENINSULA OF VIRGINIA.

B. Doerhoefer, T. B. Neblett, H. E. Sturgill, and R. S. Wood;  
*Washington and Lee University.*

Microscopic study of the heavy minerals found on the Eastern Peninsula of Virginia shows that the same minerals occur in equal abundance on both the west and east sides. Because only little is known about currents and sediments of the Delaware and Susquehanna rivers, it is impossible to precisely pin down the formations from which the sediments of the Eastern Peninsula were derived.

15. MINERALOGICAL STUDIES OF SEDIMENTS FROM NEW RIVER, VIRGINIA.

Charles A. MacIntosh, Alan R. Mixson, and David K. Willard;  
*Washington and Lee University.*

This paper presents the results of a study of the heavy minerals in the sediments of the New River between Radford, Virginia, and the North Carolina boundary. The area covered can be divided into two distinct parts. The southern section contains the Pre-Cambrian crystalline schists of the Lynchburg gneiss and the Grayson granite gneiss, whereas the northern section contains dolomites, shales, quartzites, and limestones of Cambrian age. The study indicates that there is a decrease in abundance and variety of heavy minerals after the stream leaves the Pre-Cambrian crystalline rocks and enters the Cambrian sedimentary formations.

The principal source of heavy minerals in the sediments is the Lynchburg gneiss and the Grayson granite gneiss. Heavy minerals identified are: ilmenite, magnetite, amphibole, pyroxene, zircon, muscovite, epidote, rutile, titanite, garnet, tourmaline, staurolite, kyanite, chlorite, sillimanite, and fluorite.

16. MINERALOGICAL STUDIES OF SEDIMENTS FROM THE BANISTER RIVER OF VIRGINIA.

S. H. Berry, D. D. Monroe, and L. H. Simkins; *Washington and Lee University.*

A study of samples of sand collected from the Banister River in Pittsylvania and Halifax counties of Virginia shows that there is a correlation

between the stream sediments and the country rock of the adjacent drainage area. There is a marked difference in the variety of minerals found in the Pre-Cambrian crystalline rocks and those found in the Triassic sandstones and shales. Epidote is not found in sand derived from the Triassic formations whereas it is present in most of the sediments derived from crystalline rocks.

#### 17. PROPOSED NEW SYSTEM OF SOIL CLASSIFICATION.

G. H. Robinson and S. S. Obenshain; *U. S. Department of Agriculture and Virginia Polytechnic Institute.*

This proposed scheme reflects zonality of soils, but is based upon several critical horizons whose presence or absence provides a key to either lack of development or to dominant soil-forming processes that have been active. Minerals soils are separated from the organic soils in the highest category (VII), and divisions of mineral soils are based upon the kinds of soil horizons present. Category VI (Great Soil Groups) is based upon genetically significant A and B horizons, and the group is a little broader than most Great Soil Groups recognized by Dr. Marbut. Category V (Little Soil Groups) maintains the kinds of A and B horizons of Category VI, but is subdivided on the basis of the presence or absence of extra horizons. Category IV (High Family) subdivides the units on the basis of the central concept for a given Little Great Soil Group, and intergrades in properties from one unit in Category V with properties of other units of Category V. Category III (Low Families) is based upon uniformities within the groups of soils with relation to those physical properties that affect the development of roots and their relationships to soil moisture. The criteria used for Low Families include textures of all horizons below the A, permeability of all horizons, drainage classes, and consistence when moist and dry. Little or no changes have been proposed in Category II and I, soil series, and soil types. The above material is from a working draft of what is hoped will soon be a scheme of soil classification suitable for publication and general use. Suggestions and criticisms are invited.

#### 18. SOILS-ROCK RELATIONSHIPS OF FAIRFAX COUNTY, VIRGINIA.

J. F. Derting and H. C. Porter; *Virginia Agricultural Experiment Station.*

Fairfax County comprises 410 square miles including the Piedmont Uplands, Piedmont Lowlands, and Coastal Plain provinces. Each of these provinces contains a number of geological formations, and on each formation many soil series have been developed.

The intrusion of igneous materials and consequent baking of the surrounding shales and sandstones in the Triassic Lowlands is an interesting and controversial study. The development of a catena of soils from a given formation is exemplified by the quartz-sericite schist formation.

The Coastal Plain is composed of many terraces. Each terrace presents

a study within itself as well as its relation with other terraces. The inter-mixing of soils developed from isolated remnants of high lying Coastal Plain deposits with very similar soils developed from residual materials is probably the field in which the soil scientist can learn most from the geologist.

19. HEAVY-MINERAL CORRELATION IN COASTAL PLAIN SEDIMENTS.

Allen Sinnott; *U. S. Geological Survey.*

Drill cuttings of samples collected across the Pleistocene-Miocene contact in an exploratory test hole recently drilled on the Eastern Shore were prepared for petrographic study in order to determine whether correlation based on microfauna would be accompanied by changes in the relative abundance of certain heavy mineral species. Preliminary results indicate that pyrite, garnet, and altered grains of various minerals are more abundant in the section thought to be Miocene than in that thought to be Pleistocene, whereas zircon and kyanite are less abundant in the Miocene than above. The method thus appears to show promise, and additional work is planned to test the method as a correlation tool on samples, barren of microfossils, from other holes drilled on the Eastern Shore.

20. QUANTITATIVE STUDIES OF A MIOCENE AQUIFER ON THE EASTERN SHORE PENINSULA, VIRGINIA.

G. C. Tibbitts, Jr.; *U. S. Geological Survey.*

Near Hallwood in Accomack County, on the Eastern Shore Peninsula, Virginia, a pumping test was made in April, 1955, at a cannery the wells of which tap water in a Miocene aquifer. After allowing the piezometric surface to stabilize for 2 days, one well was pumped at a constant rate of 194 gallons per minute for 6 hours, while measurements of drawdown were made at another well 404 feet from the discharging well. Solving the Theis equation graphically, the coefficients of transmissibility and storage were determined to be about 7,500 gallons per day per foot and  $4 \times 10^{-4}$ , respectively. These values indicate an artesian aquifer of low to moderate productivity.

The most important application of coefficients such as these is in estimating the effect on the water level in wells caused by discharge from other wells, which information is essential in predicting the practicable yield of well fields and of whole aquifers.

BUSINESS MEETING

At the close of the technical session, which was attended by 61 geologists, the nominating committee placed the following names in nomination for section officers for 1955-56. All were unanimously elected.

*Chairman*, William T. Parrott

*Vice-Chairman*, Troy J. Laswell



*Secretary*, Robert S. Young  
*Section Editor*, W. D. Lowry

The meeting adjourned at 4:00 P.M.

SATURDAY, MAY 14, 1955 — 8:30 A.M. — FIELD TRIP

At 8:30 A.M. a group of about 35 geologists left Harrisonburg, in a pouring rain, for the annual field trip. Because of the weather, the order of the stops was reversed and the group drove to Stephens City where the underground limestone mine of the M. J. Grove Lime Co. was inspected. The next stop was at the open pit quarry of the same company near Middletown. Following lunch at Strasburg, the Tumbling Run section of New Market, Lincolnshire, and Edinburg formations was studied; this was followed by inspection of Orando and lower Martinsburg rocks nearby. In the vicinity of Timberville, the Bowers zinc-lead prospects were visited, and west of New Market the old Wise zinc prospects were studied. Leaders were: R. S. Edmundson, Paul Herbert, and R. S. Young. The group disbanded at 4:00 P.M.

## MINUTES OF THE SECTION OF MEDICAL SCIENCE [9]

SIDNEY SOLOMON, *Chairman*

GROVER C. PITTS, *Secretary*

EBBE C. HOFF, *Section Editor*

FRIDAY, MAY 13, 1955 — 10:00 A.M. — ROOM 25, WILSON HALL

1. SEPARATION BY MEANS OF AZIDE OF ACTIVE SODIUM TRANSPORT FROM RESTING ION EQUILIBRIUM IN ISOLATED FROG SKIN.

E. G. Huf, J. P. Wills, and N. A. Streever; *Medical College of Virginia.*

Normal frog skin contains approximately 350  $\mu\text{Eg Na}$  per gm. of dry skin. The potassium content is of the order of 180  $\mu\text{Eg/gm.}$  of dry skin. Such skins under proper experimental conditions are able to actively transport NaCl from Ringer's solution at the epithelial side of the skin to the solution at the corium side of the skin. No changes in sodium and potassium content were found when skins were kept for 8 hours at 20° C. in Ringer's solution containing 0.5 to  $2.0 \times 10^{-3}$  molar sodium azide. At this azide level active salt transport, however, was decreased to about 1/3 the normal rate.  $1 \times 10^{-2}$  molar azide will lead to increase of sodium and decrease of potassium content of the skin (500  $\mu\text{Eg Na}$  and 70  $\mu\text{EgK/gm.}$  of dry skin). These findings suggest that the mechanism involved in the maintenance of normal Na/K distribution between cell and environment is different from the mechanism engaged in active  $\text{Na}^+$  transport. Azide may be used to bring about a functional separation of these two mechanisms. It is visualized that the differences in these mechanisms lies either in their location within the cell, or in their chemical characteristics, or in both location and chemical characteristics. It also follows from this work that studies on the effect of enzyme inhibitors on active salt transport should be designed such that disturbance of the normal resting ion equilibrium between cell and environment is not interfered with by the inhibitor.

2. THE COMBINATION OF INSULIN WITH FROG SKELETAL MUSCLE.

D. R. H. Gourley; *University of Virginia.*

In the presence of sodium lactate insulin stimulates the oxygen consumption and the net uptake of potassium ions by intact frog skeletal muscles *in vitro* (Am. J. Physiol., 179: 378: 1954; Biol. Bull., 99: 312: 1950). These effects of insulin may occur at the surface of the muscle cells since it is unlikely that protein molecules can pass through the membranes of living cells. When a muscle is exposed for one minute to insulin (0.05 U/ml.) and subsequently washed vigorously two times in large volumes of Ringer's solution, significant stimulations of oxygen

consumption and potassium uptake are observed. Thus there must be a strong combination of the hormone and the muscle tissue. However, the effects observed under these conditions are not so great as those observed when insulin is present throughout the 6-hour incubation period. Increasing the exposure period to 5 minutes does not result in a corresponding increase in the two effects over those caused by the one-minute exposure suggesting that the combination occurs very rapidly. When the insulin concentration is increased tenfold (0.5 U/ml.), exposure of the tissue for one minute results in approximately the same degree of effect on oxygen consumption and potassium uptake as continued exposure to the lower concentration. It is suggested that there are specific sites on the cell surfaces which bind insulin. These sites can be saturated either with a high concentration of insulin for a short exposure period or a low concentration for a long exposure period.

3. STUDIES ON THE ACTIVITY OF THE DETRUSOR MUSCLE WITH SPECIAL REFERENCE TO THE EFFECTS OF ELECTRICAL STIMULATION OF FOREBRAIN STRUCTURES.\*

Everett H. Ingersoll, Louise L. Jones, and Erling S. Hegre;  
*Medical College of Virginia.*

By photographically recording the activity taking place in all regions on the exposed surface of the bladder we (J. Urol., 61: 1037, 1949; *ibid.*, 72: 178, 1954; Proc. Soc. Exp. Biol. & Med., 88: 46, 1955) have shown that electrical stimulation of the hypogastric, as well as the pelvic nerves, evoked responses in all portions of the detrusor muscle. The response following hypogastric nerve stimulation was always diphasic. It consisted of an initial contraction followed immediately by marked relaxation. Excitation of the pelvic nerves, with few exceptions, resulted in a prompt, vigorous, and sustained contraction of the vesical wall.

Following electrical stimulation of forebrain structures such as the frontal cortex, basal ganglia, thalamic or hypothalamic nuclei, the response was usually similar to that obtained following pelvic nerve activity. Furthermore, the response was abolished by section of the pelvic nerves. Occasionally a response was elicited from the basal ganglia, thalamic or hypothalamic nuclei which was similar to the diphasic reaction evoked during stimulation of the sympathetic outflow to the bladder. Section of the pelvic nerves in these instances did not always alter or abolish this response. The third type of response obtained from stimulation of forebrain structures was a marked relaxation of the detrusor muscle, which, like the diphasic response, often persisted after section of the pelvic nerves.

From these data we infer that the hypogastric, as well as the pelvic nerves, play a role in vesical activity. This supports an opinion expressed by Wang and Harrison some years ago.

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\* This investigation was supported in part by a Veterans Administration Contract and a grant from the National Institute of Health.



#### 4. SERUM PROTEIN PATTERNS IN RABBITS DURING SENSITIZATION AND DESENSITIZATION.

Oscar Swineford, Cornelia Hoch-Ligeti, and Karen Irvine; *University of Virginia*.

Rabbits were immunized by repeated intraperitoneal injections of crude polysaccharides from *Ascaris* coelomic fluid and from egg white proteins. During immunization the total proteins in the serum, the  $\alpha_2$ , and  $\gamma$  globulin fractions, and the protein bound carbohydrates showed a significant increase. The rabbits were desensitized by intraperitoneal injection of large doses of antigen. During desensitization the amount of  $\gamma$  globulin decreased and the  $\alpha$  and  $\beta$  globulins split into several smaller fractions. The splitting of the globulins was observed until about 2 weeks after the desensitizing injections. About 5 weeks after all injections were terminated the percentage composition of serum protein components returned to the pre-sensitization levels.

#### 5. MOTION PICTURES OF CELLULAR CHANGES IN TISSUES OF TADPOLES AFTER X-RAY IRRADIATION AS RECORDED *in Vivo*.\*

Carl Caskey Speidel; *University of Virginia*.

Tadpoles were relatively resistant to whole-body x-ray treatment. Doses of 1,000 roentgens or less caused no noticeable cellular damage over the observation period of 58 days. Doses of 10,000-100,000 roentgens, however, quickly induced visible tissue reactions and structural changes. These changes were observed *in vivo* under the microscope and recorded by cine-photomicrography. The following scenes were obtained from irradiated tadpoles after periods varying from two hours to three weeks: early circulation reaction with marked lagging of circulatory leukocytes and increased rate of diapedesis; damage to some leukocytes, erythrocytes, and blood vessels; extravasation of blood; vacuolation of endothelium; occlusion of small vessels; leukopenia; excessive sticking of erythrocytes at vessel forks; injury to some nerve fibers with early appearance of fluid between myelin sheath and axis cylinder and later degeneration; lateral-line organ atrophy; mild injury to some muscle fibers with transformation of several sarcomeres into retraction clots at muscle-tendon zones; also emaciation, vacuolation, wrinkling, and complete degeneration of some fibers; injury to the epidermal epithelium with mal-alignment of cells; contrast in melanophore behavior in normal and irradiated animals; contrast in leukocyte reaction in normal and leukopenic irradiated animals; examples of tissue destruction in irradiated tadpoles by an invading ciliated protozoon (*Tetrahymena*).

#### 6. FURTHER STUDIES ON THE INHIBITION OF PORPHYRIN SYNTHESIS BY BENZIMIDAZOLE DERIVATIVES.

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\* This investigation was supported by a research grant (PHS B-359 C) from the National Institute of Neurological Diseases and Blindness, of the National Institutes of Health, Public Health Service.

Lynn D. Abbott, Jr. and Mary J. Dodson; *Medical College of Virginia*.

We reported last year that certain alkyl-substituted benzimidazole derivatives prevented incorporation of  $N^{15}$  from  $N^{15}$ -glycine into heme by chicken erythrocytes during incubation *in vitro* (Va. J. Science, 5, 316 (1954); 6, 77 (1955)). The striking coincidence of the relative inhibitory activities of these compounds for two widely different biological systems — hemoglobin synthesis by avian erythrocytes and influenza virus duplication — suggested to us that some fundamental mechanism underlying both processes might be involved. To determine whether these compounds interfere with conversion of protoporphyrin to heme or affect earlier reactions involved in porphyrin synthesis from glycine, we determined their effect on synthesis of free erythrocyte protoporphyrin and coproporphyrin by quantitative measurement of these porphyrins produced from glycine by chicken erythrocytes incubated *in vitro*. The same benzimidazole derivatives were noted to inhibit coproporphyrin and protoporphyrin synthesis in the same relative order in the present studies as was found earlier in the inhibition of heme synthesis. Thus benzimidazole and 2-methylbenzimidazole had some inhibitory activity, but with the same concentrations the 5-methyl-, 2,5-dimethyl- and 5,6-dimethyl derivatives completely inhibited synthesis of free erythrocyte coproporphyrin and protoporphyrin from glycine. 2-Ethyl-5-methylbenzimidazole again was the most inhibitory of all.

These studies demonstrate that the effect of these compounds is not on the inhibition of conversion of protoporphyrin to heme. Inhibition of the synthesis from glycine of free protoporphyrin and coproporphyrin indicates that a step in the metabolic pathway of heme synthesis from glycine prior to porphyrin ring formation may be involved. The present technique also makes it possible to use other non-isotopic intermediates in the study of the mechanism of benzimidazole inhibition of porphyrin synthesis.

#### 7. PAPER ELECTROPHORETIC STUDIES OF SERUM LIPOPROTEINS.

J. C. Forbes and P. C. Taylor; *Medical College of Virginia*.

The distribution of the serum lipoproteins following paper electrophoresis has been studied in conjunction with the distribution of the main serum proteins. It has been found that the rate of migration of the main serum proteins was approximately the same whether the electrophoresis was carried out at 5° or at 35° C. The movement of the lipoproteins migrating with the albumin and  $\alpha_1$ -globulins was also not affected by the temperature change. However, the rate of movement of the lipoprotein fractions migrating in the neighborhood of the beta-globulins was definitely affected by the temperature change. At the higher temperature a fair percentage of the cholesterol in this fraction actually migrated faster than the beta-globulins but at 5° C. very little of this cholesterol fraction extended past the beta-globulins. Hypercholesterolo-

lemic sera showed no abnormal amount of cholesterol present in the albumin and alpha<sub>1</sub>-globulin area, the excess being found mainly with the lipoproteins in the general area of the beta-globulins. Lyophilization of sera did not affect the cholesterol migrating with the albumin and alpha<sub>1</sub>-globulins but slowed down markedly some of the cholesterol found in the general area of the beta-globulins, some of it **not migrating at all**. Extraction of lyophilized normal sera by chloroform removed little, if any, of the cholesterol which migrated with the albumin and alpha<sub>1</sub>-globulins, most of the cholesterol extracted apparently coming from the beta-lipoprotein fraction. This was also more or less the case with lyophilized abnormal sera from which most of the cholesterol had been removed by chloroform extraction. In this case, however, a small amount was also extracted from the albumin and alpha<sub>1</sub>-globulin area.

#### 8. THE ULTRAVIOLET ABSORPTION SPECTRA OF IODINATED PROTEINS.

Chalmers L. Gemmill; *University of Virginia*.

The ultraviolet absorbance spectra of thyroglobulin was determined using a purified thyroglobulin obtained from Warner-Chilcott Research Laboratories. In alkaline solution, maxima were obtained at 315, 291, and 247 mu. In acid solution, there was a marked decrease in absorbance at the 315 mu region. The addition of small amounts of iodine (KI + I<sub>2</sub>) caused a shift in absorbance from the 291 mu to 315 mu. Similar changes were observed on iodination of casein and insulin. It is concluded that the region of 315 mu gives a measure of the organically bound iodine in iodinated proteins.

#### 9. STUDIES ON THE METABOLITES OF NICOTINE.

Fletcher B. Owen, Jr. and P. S. Larson; *Medical College of Virginia*.

Studies with C<sup>14</sup> uniformly labeled nicotine in the rat (Ganz, Kelsey and Geiling, J. Pharmacol. and Exper. Therap. 103: 209, 1951) and in the dog (Bennett, Tedeschi and Larson, Arch. int. pharmacodyn. 98: 221, 1954) have shown that virtually all of the administered C<sup>14</sup> is eliminated in the urine. Present studies suggest that this is also true in the cat. Urine collected from dogs receiving C<sup>14</sup> labeled nicotine has been concentrated by freeze drying and chromatographed (descending method) on Whatman No. 1 filter paper. Tertiary amyl alcohol, saturated with a pH 5.6 acetate buffer was used as the developing solvent. Following development at 7-9 degrees C., the papers were air dried, cut into squares of 2.2 cm., and scanned for radioactivity in a gas flow counter. Peaks of activity were assumed to represent unchanged nicotine and its metabolites. Evidence has been obtained for three major and possibly four minor metabolites plus unchanged nicotine.

#### 10. SOME ASPECTS OF THE CENTRAL NERVOUS SYSTEM CONTROL OF DEFECATION IN THE CAT.



Roy L. Mundy and Eugene D. Brand; *University of Virginia.*

Codeine has been used as the defecatory stimulus in a study of the central nervous system control of defecation. Dose-response curves were determined for intravenously and intramuscularly administered codeine. The maximally effective, non-convulsive dose, 30 mg. per kg. IM, produced 86 per cent defecation in 31 tests. This dose was used in all subsequent experiments. Chronic cervical vagotomy had no significant effect on codeine-induced defecation. This indicates that in the cat, in contrast to the dog, (Koppanyi, J. Lab. and Clin. Med. 16: 225, 1930) the vagus is not essential for the response. The incidence of codeine defecation was markedly decreased by decerebration and by chronic lesions of the medulla in the region of the emetic chemoreceptor trigger zone (Borison and Wang, Proc. Soc. Exper. Biol. and Med. 76: 335, 1951). Animals whose medullary lesions resulted in refractoriness to codeine exhibited normal coordination in executing the physiologically stimulated act of defecation. This suggests that the area destroyed may be a chemoreceptor zone for defecation. The fact that 4 of 6 of these animals vomited following the administration of lanatoside C indicates that in these cats the chemoreceptor zone for emesis is intact and is anatomically distinct from the postulated chemoreceptor zone for defecation.

#### 11. AUTONOMIC EFFECTS OF A NEW SERIES OF SUBSTITUTED AMINES AND QUATERNARY AMMONIUM COMPOUNDS.

M. H. Pindell, J. K. Finnegan, and J. D. Smith; *Medical College of Virginia.*

Pharmacological study of a series of 54 compounds (derivatives of 1-phenyl-3-diethylaminopropane) revealed that many produced marked hypotension of short duration in anesthetized (pentobarbital sodium) dogs. That this hypotension was due to ganglionic blockade was shown by inhibition of the pressor effects of small doses of nicotine (0.02-0.04 mg/kg) or of DMPP (15 ug/kg) coincidentally with potentiation of the epinephrine pressor response. The active members also inhibited the response of the nictitating membrane to constant electrical stimulation (10 stimuli/second) of the superior cervical sympathetic nerve in the cat and of the vago-sympathetic trunk in the dog. DMPP induced bladder contractions were concurrently inhibited indicating parasympathetic blockade. Among the tertiary amines, the diethyl derivatives were usually the most active. Quaternization of the latter uniformly increased ganglionic blocking activity several fold, depending on the quaternizing groups. Introduction of methoxy groups or chlorine into the phenyl ring or introduction of a second alkyl or aryl group on the carbon atom adjacent to the amine grouping did not appear to greatly alter activity. The most active compounds are more potent than TEA but of about the same duration of action. In the dog, intraduodenal injection of 25 times an effective intravenous dose of the active quaternaries caused no effect on ganglionic transmission or blood pressure. Most of the compounds exhibited weak

relaxant properties on isolated rabbit ileal strips (bath concentrations of 1:100,000-1:500,000) and were cholinolytic at similar high concentrations.

12. CENTRAL NERVOUS MECHANISMS AFFECTING REFLEX LARYNGOSPASM IN THE CAT.

Eugene D. Brand, Blair M. Webb, and Harold F. Chase; *University of Virginia*.

Spasmodic closure of the larynx was produced in cats by electrical stimulation of the central cut ends of the sensory branches of the superior laryngeal nerves. Sodium pentobarbital anesthesia was used throughout. The spasm was measured by means of a balloon placed between the vocal cords. Reflex laryngospasm varied in intensity with the strength and frequency of the stimulating current. The values for threshold stimulus, threshold for maximal response, and intensity of maximal response were reproducible under a given stage of anesthesia. The response was gradually depressed with deepening of the level of anesthesia but remained present even at the stage of respiratory arrest. During stimulation respiration was depressed in expiration. Laryngospasm was occasionally seen, during such an apnea, to decrease in steps at about the rate of respiration prior to stimulus. This suggests that the respiratory pace-maker continues to fire in spite of the apnea and that its impulses inhibit the laryngeal reflex. The act of inspiration markedly inhibited the spasm. Anoxia of 1-2 minutes duration immediately prior to stimulation was without gross effect on the reflex.

13. A CRITIQUE ON THE "L-C METHOD" OF TREATING SNAKE BITES.

J. T. Wood; *University of Virginia*.

In 1953 Stahnke proposed a new method for treating snake venom poisoning. This consists of brief occlusive ligation proximal to the injury and hypothermia of the involved extremity. A case is reported in which this treatment was used initially without benefit. Five patients involving six cases of treatment with "L-C" technique are reviewed from Stahnke's report, and their course is compared with that in patients treated with antivenom and tourniquet, incision, and suction in Virginia hospitals. It is the author's opinion that the "L-C Method" should be discarded "in toto" pending quantitative animal studies to compare its efficacy with that of the conventional therapies.

NEW OFFICERS

The following new officers were elected:

*Chairman*, Grover C. Pitts

*Secretary*, Geraldins M. Duncan

*Section Editor*, Chalmers L. Gemmill.

## MINUTES OF THE SECTION OF PSYCHOLOGY [10]

GILBERT J. RICH, *Chairman*

AUDREY M. SHUEY, *Secretary-Treasurer*

HENRY A. IMUS, *Executive Committeeman*

RICHARD H. HENNEMAN, *Section Editor*

FRIDAY, MAY 13 — 9:30 A.M. — PROGRAM A,  
ROOM 21, WILSON HALL

### 1. FACTORS DETERMINING THE PROFICIENCY OF MULTIPLE TASK PERFORMANCE.

Glenn R. Hawkes; *University of Virginia.*

In previous research on simultaneous multiple task performance it was found that as the number of stimulus-response units involved, and the rate of responding were increased, there was a deterioration in level of performance. An experiment, designed (utilizing a bi-manual task) to provide rapid choices of responses with easy discrimination of stimuli, was set up with the following variables: (1) rate of stimulus presentation at two/second or one/second; and (2) temporal phase relations among the response components of the task ("in-phase" where stimuli for both hands were presented simultaneously, and "out-of-phase" where stimuli for the two hands were presented one-fourth second apart).

Stimuli consisted of two sets of four lights each, and corresponding sets of four keys, one for each hand. Instructions were given to respond to a random presentation of lights by pressing the appropriate key while the light was on. A trial consisted of a two-minute session followed by two minutes of rest. Each S was given 10 trials per day for four days (it having been determined from preliminary practice that learning curves would asymptote after this amount of practice). Sixteen Ss were used, 4 per cell of a 2 x 2 design.

It was postulated that both increased rate of stimulus presentation and out-of-phase relations would cause a decrement of performance. Data-taking is near completion, results and conclusions to be reported.

### 2. VIBROTACTILE COMMUNICATION AND TRAINING.

William C. Howell; *University of Virginia.*

The practical advantages and limitations of a communication system dependent upon vibratory cues are presented. The various characteristics of the vibratory stimulus are then reviewed, and the feasibility of employing each as a dimension in a vibratory communication system is discussed. The results of systematic investigations of sensitivity along three of these dimensions are reviewed: intensity, locus, and duration. There follows



an account of studies designed to determine a method of integrating these dimensions into a system producing discrete stimulations of sufficient number to transmit a variety of messages. The possibilities of training on such a system are discussed in view of findings from experiments currently in progress, and plans for future research in this area are given.

### 3. THE INFLUENCE OF VARYING PROBABILITIES OF REINFORCEMENT IN A MATCHING-TO-SAMPLE SITUATION WITH HUMANS.

William E. Montague; *University of Virginia.*

The Estes-Burke association learning theory provides a mathematical model capable of predicting rate of acquisition and asymptotes in simple learning situations. It has been found, for example, that the empirical asymptote of response probability turns out to be equal to the probability of reinforcement as predicted by the model. The present experiment utilized this model to examine the rats and asymptotes of learning in a matching-to-sample situation.

Three groups of ten undergraduate male students were used as Ss. They were presented stimuli projected in sequence from strip film. The stimuli were geometrical figures (squares and triangles, black or white). The task was to choose between color or form on each trial; a trial consisted of: a frame with a sample figure, a frame with two figures each one containing one property of the sample figure (color or form), a final frame with the reinforcement figure. Each group received 120 trials (sequence A) with different probabilities of reinforcement. Group I received 30 per cent reinforcement for form and 70 per cent for color; Group II received 50 per cent reinforcement for form and 50 per cent for color; Group III received 85 per cent reinforcement for form and 15 per cent for color. Following sequence A, all three groups received another sequence of 120 trials; here the same probability of reinforcement, *i.e.*, 30 per cent for form and 70 per cent for color, was used for all groups.

The results tend to support the findings of other research with simple association learning. The empirical rates of responding reach their asymptotes at the theoretical level, *i.e.*, the level corresponding to their probabilities of reinforcement.

### 4. AN INVESTIGATION OF THE STIMULUS DIMENSIONS IN VIBRATORY "PHI."

William H. Sumby; *University of Virginia.*

A psychophysical investigation is reported, the purpose of which is to determine the stimulus relationships critical for the occurrence of the phi phenomenon on the skin when induced by vibrotactile stimulation. The design of the transducer system, its reliability and limits are briefly discussed. The occurrence of vibratory "phi" is discussed as a function of the interaction of the following variables: 1) the intensity of vibration, 2) the duration of stimulation delivered by each of two vibrators succes-

sively energized, 3) the temporal interval between successive vibrating "bursts", and 4) the spatial separation of the stimulators on the body surface. A comparison of the obtained results and Korte's laws for visual phi is drawn. In addition, a comparison is made between the stimulus property relationships optimal for the occurrence of phi when a body area highly sensitive to such stimulation is the locus of vibration (*e.g.*, the volar side of the forearm) and when a less sensitive surface is used (*e.g.*, the lumbar region of the back).

##### 5. STEREOTYPES AND PERCEPTUAL DISTORTION.

Linda Johnson; *Mary Washington College.*

This study was designed to investigate the influence of stereotyping upon the perception of human physiognomy. Physiognomy in this study is not considered from the standpoint of the validity of its relationship to personality, but serves as the visual stimulus in testing the following two hypotheses: 1) that perception of physiognomy will be distorted if a photograph is presented in conjunction with a personality description which arouses a stereotypic idea, and 2) that the direction of distortion will be toward the stereotypic idea.

One group of Ss was presented two short personality descriptions, one giving a positive and the other a negative impression. Ss were asked, after hearing each description, to form an imaginary picture of a person having that type of personality and to rate this image on a physiognomic rating scale having 32 physiognomic traits.

Other groups were presented with full-face photographs of men and one of the personality descriptions; they were asked to rate the photographs on the physiognomic rating scale.

An analysis of the data revealed that personality descriptions induced distortions in 48 photographic ratings. Thirty of these were in the direction of the stereotype. These results are interpreted as support for the two original hypotheses and are discussed in terms of current perceptual theory.

##### 6. THE EFFECT OF STIMULUS REVERSAL ON DISCRIMINATION CHAINING.

Milton H. Hodge; *University of Virginia.*

The present experiment was designed to determine the nature of transfer of extinction in a chain of responses as a function of the temporal position of the extinguished response. Sixteen food-deprived rats were terminally reinforced to correctly choose one of two stimuli at two different choice points in a linear discrimination box. As a control measure, half of the animals learned the chain with brightness stimuli at the first choice point and pattern stimuli at the second choice point, and half learned the chain in reverse order. When the chain was well established, eight animals were given 70 trials of reversal training with stimuli that were either at the first or second choice point during the acquisition period. The remaining animals were maintained on the deprivation

schedule in their living cages during the 70 trials. All Ss were then given reversal training to a criterion with the stimuli not employed in the first reversal. The experimental results are analyzed by means of a  $2 \times 2 \times 2$  factorial design. These results and theoretical interpretations are discussed.

7. VISUAL RECOGNITION THRESHOLDS AS INDICES OF WORD PROBABILITIES.

William A. Lee; *University of Virginia*.

Solomon and Howes have proposed that visual recognition thresholds for words are a function of response probabilities of the words. The relevant literature is reviewed, and it is concluded that available data tend to support the hypothesis, but not strongly enough to warrant, without further research, the use of recognition thresholds as a tool in the investigation of verbal behavior.

8. THE RETENTION OF RESPONSES TO SPECIFIC VERBAL STIMULI COMPARED WITH THE RETENTION OF RESPONSES TO CLASSES OF VERBAL STIMULI.

Kenneth E. Lloyd; *University of Virginia*.

Concepts, or classes of stimuli, are reputed to result in higher retention than non-conceptualized material. This study tests the thesis that no differences in retention should be observed if the number of response units to be learned is equal in both situations.

Four experimental groups of 21 Ss each associated eight numbers with either eight specific words, or eight classes of words with three instances each, *i.e.*, 24 words. Using a memory drum two groups practiced to one perfect trial, and two groups practiced for five trials. A trial was 24 responses. Following the recall trial one week later, Ss learned a second list with "new" stimuli and "old" responses. Ss in the "class" groups were assumed to be responding to the words as members of classes; if so, then they should respond to "new" instances of "old" classes more efficiently than Ss in the "specific" groups. The transfer task tested this prediction.

With the number of responses equal, no superiority in retention of conceptualized material was observed. However, class groups were superior on the transfer task. As measured here retention appeared to be related more to the degree of original learning than to possible qualitative differences in the stimulus material.

PROGRAM B, ROOM 32, WILSON HALL

1. CRITERIA FOR ENROLLING COLLEGE STUDENTS IN "IMPROVEMENT OF READING SKILLS" COURSE.

Frances Dean Scott; *Lynchburg College*.

The paper deals with the most efficient method of enrolling stu-



dents in an "Improvement of Reading Skills" course. The usual criterion has been that of including the lowest one-fourth or lowest one-third of students according to their percentiles on a standardized reading test. The criteria which are developed in this paper make the most efficient use of time and equipment available for training those students who show the greatest potentiality for improvement with training.

## 2. DISPROPORTIONATE CONTRIBUTION OF REVISED BETA SCALED SCORES TO TOTAL SCORES IN ADOLESCENT GROUPS.

Walter A. Woods and Robert Toal; *Richmond Professional Institute*.

A previous study revealed that, with Negro adolescent delinquents and non-delinquents, sub-test four (spatial visualization) of the Revised Beta Examination (Lindner-Guervitz scaled scores) contributes significantly less to total score than does any other of the sub-tests.

In this study 120 Beta examinations by Negroes were matched for total score with 120 Beta examinations completed by white adolescents of the same age range. White Ss within the age and IQ range perform similarly to Negro Ss. In both groups sub-test four contributes disproportionately less to total score than do other sub-tests, according to F test. Treatments-by-levels analysis of variance and F test for interaction by comparison of treatments-levels mean square to within-cells mean square reveals significant interaction effects.

It is suggested that the interaction revealed by F test is that of greater comparable difficulty at lower levels of intelligence, of sub-test four, as compared to difficulty of other sub-tests. In its present form, the Lindner-Guervitz scaled scores of the Revised Beta Examination do not appear to be valid scores for the appraisal of the intelligence of adolescent subjects.

## 3. INTELLIGENCE DIFFERENCES IN DELINQUENTS AS APPRAISED BY FOUR PSYCHOLOGICAL TESTS.

Walter A. Woods and John A. Farley; *Richmond Professional Institute*.

Mean scores are compared for four samples of juvenile delinquents: white males, white females, Negro males, and Negro females, on four intelligence tests. These are: Wechsler-Bellevue Revised Beta, S. R. A. Primary Mental Abilities, and House-Tree-Person Test. Within each sub-group each test was correlated with each other test, to ascertain common variances.

Correlations between pairs of tests among the delinquent samples suggest that these groups derive their intelligence estimates from different facets of the tests. Differences between mean scores on the various tests for the sub-groups support this finding.

Possible correlates of IQ differences are suggested, and limitations are noted in assessing intelligence of delinquents from single tests.

## 4. RESEARCH PROGRAMS IN NEUROLOGICAL DISEASES AND BLINDNESS.

Henry A. Imus; *National Institutes of Health, Bethesda, Maryland.*

The National Institute of Neurological Diseases and Blindness of the National Institutes of Health was established in 1950. Since then, comprehensive programs of fundamental and clinical research have been developed both within the Institute and in the extramural grants which are awarded to universities, medical schools, and other research centers. These programs include research on neurological disorders, such as cerebral palsy, epilepsy, multiple sclerosis, and muscular dystrophy; on sensory disorders, such as deafness, cataract, glaucoma, retinopathy; and disturbances of the other special senses. Fundamental laboratory studies are conducted jointly with the National Institute of Mental Health. These studies include investigations of neural transmission, neuronal interactions, the hypothalamus, the cerebral cortex, and the special senses. Also under investigation are the metabolism of the nervous system, the effects of hormones and drugs, drug addiction, and the development, regeneration, and aging of the nervous system. Psychological studies of perception and behavior, as well as those on human relations, are undertaken on a small scale. Clinical studies on in-patients and out-patients at the clinical center are conducted on cases of cerebral palsy, epilepsy, muscular dystrophy, and multiple sclerosis, as well as on certain diseases affecting the eyes, as toxoplasmosis, uveitis, glaucoma, and cataract.

## 5. THE MEASUREMENT OF PRIMARY MENTAL ABILITIES BY THE COLUMBIA MENTAL MATURITY SCALE.

Jack H. Boger, Cyril R. Mill, and Charles J. Turner; *Richmond Public Schools.*

The Columbia Mental Maturity Scale, published in 1954, is designed to yield an estimate of the intellectual ability of children in the mental age range from 3-12 years. It calls for no verbal response and a minimum of motor response from the S-features which were thought to make this a particularly useful tool for work with children afflicted with cerebral palsy. Since administration and scoring are brief and simple, it also has potentialities for becoming a quick device for the measurement of intelligence of normal children.

This study was an attempt to determine the degree to which certain mental abilities are measured by the Columbia Mental Maturity Scale, and its relative validity at various age levels. Ss included 75 boys and girls between ages of 7-7 and 12-6, enrolled in Richmond Public Schools. CMMS was individually administered. The SRA Primary Mental Abilities test was administered to the same Ss in small groups. Correlations were obtained between the total Columbia Mental Maturity IQ and scores for the five Primary Mental Abilities, and the Total Score and Total Non-Reading Score of the PMA.

The significance and implications of these results were discussed, as

well as a general resume of certain other features of the Columbia Mental Maturity Scale which have become apparent with increasing use.

6. RECENT RESEARCH IN PERCEPTION AND ITS IMPLICATIONS FOR RESEARCH WITH PROJECTIVE TECHNIQUES.

A. W. Jeffreys, Jr.; *Western State Hospital*.

An appeal is made for clinical psychologists to abandon a test orientation kind of approach to clinical psychology and attempt to establish a more systematic theoretical basis for the interpretation of psychological tests, especially the projective tests. The present need is for a shift from tests as the subject of study to that of behavior. By studying the behavioral processes of an individual and the way in which this behavior is measured by tests, much faster and more scientific progress can be made invalidating projective techniques.

Research in perception in recent years provides one starting point for the development of the needed theory. With an emphasis on the perceiver in the study of perceptual processes, recent investigators have been able to demonstrate promising dimensions of personality. Perception is regarded as the window for viewing and measuring the otherwise elusive dynamics of personality. The work of Klein, Witkin, and Jeffreys exemplifies this approach. Beginning in the laboratory they have been able to arrive at rather precise measurements of perceptual functioning and show how these behaviors are reflected in other tasks such as projective tests.

7. TO SEARCH FOR EVIDENCE ON THE POPULAR BELIEF THAT MALES ARE MORE LOGICAL IN THEIR REASONING PROCESSES THAN FEMALES.

Antonia Bell Morgan; *Apptitude Associates Inc., Merrifield*.

The Morgan Test of Logical Reasoning, first developed in 1946 for the testing of superior adults for Government employment, consisting of 75 true-false items in verbal form, scored Right minus Wrong, was given in 1951 and 1952 to 133 males and 35 females, all of whom were alike in that they:

- (a) were all college graduates with either the BA or BS degree
- (b) had no degrees other than the BA or BS
- (c) were all between the ages of 20-29, inclusive
- (d) were all applicants for Government employment
- (e) had never taken courses in formal logic.

No significant differences whatsoever were found between these two groups. The median for both groups was 27; mean for females was 27.4, sigma 12.4; mean for males was 28.7, sigma 13.3. The frequency curves reveal that the distribution of scores was the same.

It was concluded that no significant differences in scores were found between a group of adult males and a comparable group of adult females on a verbal-type test of logical reasoning.



8. A VALIDITY STUDY OF THE MORGAN TEST OF LOGICAL REASONING  
IN TERMS OF CAREER EMPLOYEES FOR GOVERNMENT SERVICE.

William J. Morgan; *Aptitude Associates Inc., Merrifield.*

An agency of the Government, engaged in international affairs, selected 55 college graduates for career employment, doing so without direct recourse to a testing program. The Civil Service application papers of thousands of candidates were reviewed, and hundreds were personally interviewed by personnel officers. Those who were judged to be most likely career employees were given a final-type interview by a Board of Three, consisting usually of a psychologist and two educators. Program carried out in 1951 and 1952, and 55 career employees were selected. After they reported for employment they were given a battery of tests, one of which was the Morgan Test of Logical Reasoning.

The 55 career employees obtained a mean score of 35.4; the sigma was 13.0; lowest score was 7, the highest, 60. The mean for this group is the highest yet obtained in the use of this test in thousands of cases. This group did significantly better on this test than various "comparable" groups of college graduates, all of them applicants for Government employment. The comparative groups included: 170 graduates with BA or BS degree, 107 with MA or MS degree, 71 college graduates, all of whom had studied formal logic. As a group, the 55 did somewhat better than a group of 9 Ph.D's. Role of age, extent of education, and formal training in logic are considered in interpreting the results obtained.

The Morgan Test of Logical Reasoning appears to have value as a practical discriminant in the selection of career personnel for Government employment.

BUSINESS MEETING

The business meeting was opened by the Chairman at 3:00 P.M. The Secretary-Treasurer reported a membership of 92; receipts of \$222.50, of which \$188.00 was sent to the Academy Treasurer and \$34.50 to the Treasurer of the Conference of State Psychological Associations. Announcement was made of the re-appointment by the Executive Committee of Dr. Henneman to succeed himself on the Examining Board for Clinical Psychologists for a full term of five years and the appointment of Dr. William E. Harris to fill the vacancy resulting from the resignation of Mr. Grigg.

A report of the committee appointed last year to re-examine and re-evaluate the constitution, functions, and responsibilities of the Psychology Section, was made by its chairman, Dr. Morris Roseman. The committee report was accepted, and a motion was made to proceed according to the recommendation of the committee, *i.e.*, that a representative Constitutional Committee be appointed to draw up a constitution accommodating the various roles and needs of an organization of Virginia psychologists — within the framework of the Academy if possible — and that a written report be presented to the Executive Committee at least

one month before the Academy meeting in 1956. After discussion from the floor pertaining to the inability of the Section to deny membership to anyone, to the need for money to be used in the Section, and to the legislative and lobbying power of sections of the Academy, the motion was unanimously carried.

It was reported that the Section is practically without funds for carrying on a committee investigation. A motion was made and carried that the psychology section authorize a small assessment of members for one year, the expenditure not to exceed \$3.00 per person.

Dr. Henneman asked the members for contributions to the Virginia Journal of Science.

The report of the Nominating Committee was presented and the following persons were re-elected officers for the coming year:

*President*, Gilbert J. Rich

*Secretary-Treasurer*, Audrey M. Shuey

*Executive Committeeman*, Henry A. Imus.

A brief report was made by Dr. Hinton, the representative to the Conference of State Psychological Associations. Following his expressed wish that he be re-placed, the Executive Committee named Dr. Reuben Horlick as a delegate to the Conference, the chairman to serve as alternate.

The Chairman brought for the consideration of the group a proposed agreement drafted by the Committee on Relations with Psychiatry of the APA and the Committee on Relations with Psychology of the American Psychiatric Association. This proposed agreement involved a "moratorium" on certain types of legislation, a plan for the advancement of other types of legislation, and suggestions for further discussion and research in connection with problems of mutual concern to the two organizations. After discussion the members voted to accept the proposed agreement.

The meeting was adjourned at 5 P.M.

## MINUTES OF THE SECTION OF SCIENCE TEACHERS [11]

G. L. THOMASSON, *Chairman*

FRANKLIN D. KIZER, *Chairman-Elect*

MARTHA W. DUKE, *Secretary*

CAROLINE GAMBRILL, *Section Editor*

FRIDAY, MAY 13, 1955 — 9:30 — ROOM 103, BURRUSS HALL

### BUSINESS MEETING

Mr. Thomasson appointed Mr. L. W. Jarman as chairman of the nominating committee, which included Miss Virginia Ellett and Mr. A. B. Niemeyer. The following slate was presented:

*Chairman-Elect*, Miss Samuella Crim

*Secretary*, Miss Martha W. Duke

As there were no nominations from the floor these officers were re-elected. More than sixty persons attended the meeting, which was very gratifying.

#### 1. NEW TRENDS IN BIOCHEMISTRY.

Dr. Sidney S. Negus; *Medical College of Virginia*.

Biochemistry has been of age for only about fifty years. During this time new trends of biochemical research have appeared. Stressed today are the dynamic aspects seeking to explain in chemical terms transformations taking place in living organisms. A second trend is a study of the chemistry of homogeneous cells rather than of whole living organisms. Studies show the specific ways in which complex substances are made in the body and intermediate products formed. They show the astonishing speed with which body constituents are being built and broken down. Basic researches on yeast cells have revealed that a mixture of three different co-enzymes was necessary in alcoholic fermentation. Oxidation of glucose in the human body requires the same or similar enzymes. Studies of co-enzyme systems show that probably all vitamins are parts of such systems.

So, beginning with the study of yeast cells, there has been built up a tremendous amount of biochemical knowledge dealing with how energy is released from foods, how vitamins function, how certain chemotherapeutic agents act, as well as facts about the boundary lines between the living and the dead. These are just glimpses of modern biochemistry.

#### 2. LIQUIDS AT HIGH TEMPERATURES.

Dr. G. P. Smith; *Oak Ridge National Laboratory*.



Substances which can exist as liquids at high temperatures are held together in condensed phases by forces which are fundamentally different from the forces which are active between the molecules in most familiar liquids. For this reason many of the properties of liquids at high temperatures are very different from the properties of ordinary liquids. During the past fifteen years the development of new experimental methods for high temperatures in research has brought about a renaissance in the study of liquids at high temperatures.

Recent studies of oxidation and reduction reactions, polymerization reactions, and some electrode processes at high temperatures in liquid phases were discussed together with some of the applications of these reactions to the synthesis of new kinds of inorganic compounds and to the development of new procedures in chemical analysis.

### 3. PROTEIN FIBERS.

Dr. Carl J. Likes; *Virginia Institute of Scientific Research.*

Steady improvement in the field of regenerated protein fibers has resulted in their increased use and production and has stimulated increasing interest in further developments of this type of synthetic fiber. Regenerated protein fibers are being produced commercially in this country from corn and soybean protein and in Europe from milk casein and peanut protein. The fibers are very similar to wool in fiber properties and are currently being used predominantly in the form of blends with most of the standard fibers, both natural and synthetic. The production and development of these fibers will be reviewed, supplemented by a brief summary of the principles of fiber formation.

### 4. TREND IN SCIENCE TEACHER SUPPLY.

Professor Murl C. Shawver; *Madison College.*

An investigation of one aspect of the white high school science teacher supply for 1955 in Virginia was reported. The questionnaire technique was employed in securing information. Inquiries were sent to twenty-one colleges and universities in the state.

Seventeen institutions supplied usable data. It was learned that forty college students who had majored in one of the areas of science will constitute a part of the teacher supply for Virginia High Schools for the fall of 1955. Biology led with 19 majors (8 men and 11 women); chemistry was next with 10 majors (3 men and 7 women); general science followed with 6 majors (3 men and 3 women); physics was last with five majors (one man and 4 women). The study showed that in the fall of 1954 the needs for staffing Virginia's white high schools were as follows: 67 new general science teachers, 16 new biology teachers, 9 new chemistry teachers, and 2 new physics teachers. National trends in the failure of college graduates, qualified to teach science in the high schools, to take teaching positions the next fall were applied to Virginia's science teacher supply.

The two institutions preparing the greatest number of science majors, of those indicating an interest in teaching high school science, were the University of Virginia (10) and Longwood College (9).

In another aspect of the study it was found that during the first semester of the 1954-55 session almost 60% of the students of 16 Virginia colleges and universities were enrolled in at least one science course.

12:00—Adjournment to the Junior Science Hour.

## MINUTES OF THE SECTION OF STATISTICS [12]

W. S. CONNOR, *Chairman*

M. C. K. TWEEDIE, *Vice-Chairman*

CLYDE Y. KRAMER, *Secretary*

LIONEL WEISS, *Section Editor*

FRIDAY AND SATURDAY, MAY 13, 14, 1955 — ROOM 301,  
BURRUSS HALL.

### 1. SOME RESULTS ON RECURRENT EVENT THEORY.

John E. Freund; *Virginia Polytechnic Institute.*

This is a preliminary report on the development of a continuous exceedance test for the comparison of two Poisson processes. The fundamental theorem of recurrent event theory is generalized to apply to this case, and some results on first occurrence times are derived.

### 2. A PROPERTY OF THE BALANCED INCOMPLETE BLOCK DESIGNS.

W. A. Thompson, Jr.; *Virginia Polytechnic Institute.*

It is a well-known property of the B.I.B. design that all treatment effects are estimated with the same accuracy, *i.e.*, that the variances of the estimates of the treatment effects are all equal and their covariances are also all equal. We show that the converse is also true. If the estimates of the treatment effects in an incomplete block design all have the same variances and the same covariances, then the design is B. I. B.

### 3. ON PARAMETER ESTIMATES EXPRESSED AS SETS OF VALUES.

M. C. K. Tweedie; *Virginia Polytechnic Institute.*

The main objectives of this paper are to demonstrate (a) that properties which are desirable in tests of statistical hypotheses, according to the Neyman and Pearson theory, do not necessarily have direct equivalents in estimation procedures, despite statements or implications to the contrary in a number of publications; (b) that comparisons of probabilities in a way not actually used by Neyman in his principal paper (1937) on confidence intervals can be applied to discrete distributions, thus overcoming some of the frustration experienced in attempting to apply the Neyman and Pearson theory of tests to estimation in such distributions; and (c) that (at least in estimating a one-dimensional parameter from a single value of a one-dimensional variate) estimates as points, or as intervals of minimal length, can be based on the idea that the observed value is the mode of the population sampled, and that with continuous variables, after suitable transformations if necessary, this gives the point estimates of maximum likelihood.



## 4. ON THE NUMERATION OF CONSISTENT PAIRWISE COMPARISONS.

R. L. Wine and John E. Freund; *Virginia Polytechnic Institute*.

Each of the  $\binom{n}{2}$  pairwise comparisons of  $n$  means, for example  $m_1$  and  $m_2$  shows a preference for  $m_1$ , a preference for  $m_2$ , or no preference between  $m_1$  and  $m_2$  which is written as  $m_1 m_2$ ,  $m_2 m_1$ , or  $m_1 m_2$ , respectively. In general, for any two means, the mean written to the left is preferred if they are not joined by a common underline, and there is no preference if they are joined by a common underline. On comparing  $n$  means, there are many possible patterns of underline which show preference or no preference of each of the  $\binom{n}{2}$  pairs of means. Recursion formulas are derived which give the total number of such patterns.

## 5. VARIOUS APPROACHES IN EVALUATING CENSUS DATA.

Glenn W. Suter; *Bureau of the Census*.

The 1954 Census of Agriculture was the first census to be taken in the fall months. This produces some new problems in determining the quality of the statistics. The Crop Reporting Service made a special mail and enumerative survey to determine the change in livestock numbers between the census enumeration date and January 1, 1955. This survey was tested in the fall of 1953 when a Sample Census of Agriculture was made in Virginia and Utah.

The Census Bureau is making a special series of studies on the quality of the current Census of Agriculture. Sample segments were re-enumerated with a more thorough set of questions on farm acreage. All the acreage within the segment boundary and all land associated in any way with the segment was accounted for and mapped. In this way several types of expansions of the sample data can be made. Farms showing discrepancies from the original census enumeration in acreage in farms or crops harvested were revisited to determine what the correct answers were and why the discrepancies existed.

The results of these surveys have added new considerations in the making of agricultural enumerative and mail surveys.

## 6. SOME ANTECEDENTS OF MODERN EXPERIMENT DESIGN.

Churchill Eisenhart; *National Bureau of Standards*.

Examples are given of the explicit use, a century or more ago, of weighing designs in metrology; and of components of variance, in astronomy and geodetic surveying. The latter appears to have become a lost art in the physical sciences about 50 years ago, and seems now to be a tool primarily of biometricians and other statisticians. By 1907, use of certain special classes of weighing designs of the chemical-balance type had become standard practice in metrology, in connection with the calibration of graded series of weights. Such designs are today employed

regularly in this type of work, the selection of a particular design in a given case being influenced not only by the precisions with which the individual weights may be determined, but also by the internal checks against gross errors that it affords at successive stages of the work. Various other types of incomplete-block designs occur naturally in geodetic surveying operations; and the least-square estimates of the "treatments" and their respective standard errors may be found in manuals of geodetic surveying of 50 years ago and earlier. The systematic exploitation of such designs as a tool of experimentation is, however, a modern development, sparked by a geodetic surveyor become statistician, F. Yates.

#### 7. ESTIMATION OF AIRCRAFT SPARE PARTS REQUIREMENTS.

Walter Jacobs; *Department of the Air Force.*

In estimating the budgetary provision for spare parts required for aircraft and engine maintenance, the Air Force presently uses a detailed procedure similar to that used to specify the actual quantities to be procured. Since upward of a million individual items are involved, this involves a very large computation. However, since the budget estimate is based on a tentative program subject to change, the exact computation may not be needed, provided that a sufficiently dependable approximation can be obtained.

An approximation is developed on theoretical grounds, and some figures are presented to indicate that a simple formula or set of formulas will yield suitable accuracy.

#### 8. A STATISTICIAN LOOKS AT THE EMPLOYEE SECURITY PROBLEM.

Morris J. Solomon; *U. S. Bureau of the Census.*

Employee security and quality control are "statistical decision problems." Both require a decision to accept or reject something based on a sample of information with two types of error possible and a cost of getting information. An applicant for a job in the personnel security problem is comparable to a lot of material in quality control. Instead of sampling pieces in the lot, the security administrator takes a sample of a man's past actions.

The unique features of the personnel security problem are as follows. First, estimates of probability of a person being a "wrongdoer" are very approximate. Second, the personnel security problem deals with people who react to decisions. Third, the personnel security problem inevitably involves a multi-dimensional value judgment weighting system.

The complexity of the personnel security problem makes it economical to have the basic decisions incorporated in a code which is used as a guide for those who administer the program.

To avoid measuring value judgments, this paper uses a technique often employed in economic theory, namely the enumeration of the relationships and the direction of effects at extreme points of action, leaving the problem of specific measurement to empirical specialists.

## 9. LIFE TESTING IN THE DISCRETE CASE.

F. S. McFeely; *Virginia Polytechnic Institute*.

Minimax procedures are applied to the comparison of two geometric populations to determine optimum sample size if one of two alternatives must be accepted. Interpreting ordered observations from the two populations as failures in a discrete life test, the decision as to which is the population having the smaller mean is based on the first occurrence of the  $r^{\text{th}}$  failure. The loss function used takes into account losses due to wrong decision, items used, and cost of experimentation.

## 10. NEW DEVELOPMENTS IN PAIRED COMPARISONS.

Ralph Allan Bradley; *Virginia Polytechnic Institute*.

A method of paired comparisons developed with M. E. Terry is discussed. The method depends on comparisons of  $t$  treatments in  $n$  repetitions of the  $\binom{t}{2}$  possible pairwise comparisons. Treatment parameters,  $\pi_i \geq 0$ ,  $\sum_i \pi_i = 1$ , so that the probability that  $T_i$  ranks above  $T_j$  in a

comparison of these two treatments is  $\pi_i / (\pi_i + \pi_j)$ . Variations on this model are introduced, including factorial arrangements of treatments, and test procedures are developed.

This paper summarizes results that have been published and prepared for publication covering the development of the paired comparisons method and investigations of its properties. Asymptotic formulas (with  $n$ ) for the variances and covariances of estimators  $p_i$  of  $\pi_i$  are discussed as is the distribution of these estimators. The efficiency, based on power comparisons, of the method of paired comparisons in comparison with analysis of variance and multi-binomial analyses is given. The relative efficiency of paired comparisons relative to the analysis of variance was found to be  $t/\pi(t-1)$ .

11. CONSISTENCY OF SUBJECTIVE SCORES IN NON-REPLICATED EXPERIMENTS<sup>1</sup>T. S. Russell; *Virginia Polytechnic Institute*.

Estimates are obtained in non-replicated experiments to determine which judge or judges best summarizes the opinion of all the judges when  $r$  judges grade  $n$  items subjectively by assigning a score. These estimates are shown to be maximum-likelihood estimates in the case of three judges grading  $n$  items.

<sup>1</sup> "This work was supported in part by the U. S. Army Quartermaster Research and Development Command under Contract No. DA44-109-qm-1488. The views and conclusions in this report are those of the author(s) and do not necessarily reflect the views, or have the indorsement, of the Department of Defense."



The model assumed is

$$x_{ij} = \mu_i + \beta_j + \epsilon_{ij} \quad \begin{array}{l} i = 1, 2, 3, \dots, n \\ j = 1, 2, 3, \dots, r \end{array}$$

where

$x_{ij}$  = the score given item  $i$  by the  $j^{\text{th}}$  judge

$\mu_i$  = true score for the  $i^{\text{th}}$  item

$\beta_j$  = bias of the  $j^{\text{th}}$  judge and

$\epsilon_{ij}$  = random error which is distributed normally with mean zero and variance  $\sigma_j^2$ .

## 12. A STUDY OF ORDER STATISTICS FOR SAMPLES FROM DISCRETE UNIFORM DISTRIBUTIONS.

Elwood L. Bombara; *Virginia Polytechnic Institute.*

Order statistics often supply quick non-parametric tests of hypotheses and estimates. The theory of order statistics from discrete distributions presents difficulties which have not been fully explored. Some of these problems have been investigated in the special case of a discrete uniform distribution, where sampling is made with replacement. The distributions and lower moments of various order statistics are derived, and asymptotic values of these moments investigated in some cases. The order statistics that have been investigated are the lowest value, the  $r^{\text{th}}$  value, the highest value, the range, and the median of a sample, and also the joint distribution of the lowest and highest values.

## 13. SEQUENTIAL PROCEDURES THAT CONTROL THE INDIVIDUAL PROBABILITIES OF COMING TO THE VARIOUS DECISIONS.

Lionel Weiss; *University of Virginia.*

We consider cases where we have a finite number of decisions and a finite number of possible distributions, and we confine attention to procedures which have zero probability of continuing beyond the  $N^{\text{th}}$  observation, where  $N$  is a given positive integer. We find a class  $C$  of procedures such that given any procedure  $R$ , there is a member of  $C$ , say  $R'$ , such that the probabilities of coming to the various decisions under the various distributions when using  $R'$  are at least as desirable as when using  $R$ , and such that we are at least as likely to take fewer than  $n$  observations under  $R'$  as under  $R$ , for any  $n$ . Various extensions are indicated.

## 14. SOME ASPECTS OF QUALITY CONTROL.

D. J. Shaw; *E. I. duPont de Nemours and Company.*

Aspects of quality control covered in this discussion are those related to the management and operation of a control group. Necessity for subdivision of a quality control group into sections, each with certain func-

tions, is pointed out. It is believed that these functions vary with (a) products manufactured and (b) plant organization. At duPont in Waynesboro, the functions of the subdivisions of the quality control group are (1) developmental, (2) evaluative, (3) investigative and (4) procedure and specification writing. The work done by each section is briefly described. The placement of statistical, engineering, and plant-experienced personnel is discussed.

#### 15. INTUITIVE PROBABILITY AND ECONOMIC BEHAVIOR.

Cleon Harrell; *North Carolina State College.*

New insights into the theory of inductive behavior have important implications for economics, as one of its central problems is the behavior of decision-making units under uncertainty. The attention various intuitive or subjective approaches to probability have received in recent years is interesting in this connection, and the theories of B. O. Koopman, Carnap, and Savage are briefly discussed. The formal aspects of many of the somewhat subjective theories is very close to the formal axiomatic treatment of economic choice; this is because both involve the properties of various types of order. The plausibility of the assumption that the entities of interest in probability theory (*e.g.*, propositions, acts) and in economic theory (*e.g.*, decisions) are simply ordered is discussed. Following Georgescu-Roegen, the assumption that entities which are subject to choice comprise a partially ordered set with a maximal element will be shown to be adequate for certain classes of problems.

#### 16. A RESULT ON GEARY'S EXTENSION OF BERKSON'S CASE. OF FUNCTIONAL RELATIONSHIPS.

H. C. Sweeny; *Virginia Polytechnic Institute.*

Berkson [JASA;45(1950)164] has shown that standard regression techniques are valid when there are errors in both variates in a linear regression problem, and when the independent variable is a "controlled variable". Geary [JASA;48(1953)94] extended Berkson's argument to the non-linear case, and developed some simple sampling theory.

It is shown in this paper that, in the non-linear case

$$y = \sum_{i=1}^p \beta_i x_i + \epsilon$$

there are two and only two parameters which have linear unbiased estimates, and these are  $\beta_{p-1}$  and  $\beta_p$ . Further, it is shown that these are the same estimates which would have arisen under the usual least squares approach, ignoring errors in the independent variable. Some extensions of Berkson's case are made to the non-linear multi-variable case and similar results are proved.

## 17. DESIGNS FOR INTERBLOCK ANALYSIS.

C. C. Beazley; *Virginia Polytechnic Institute*.

In scientific experiments utilizing incomplete block designs, where a model of the form

$$y_{ij} = \alpha + \tau_i + \beta_j + \epsilon_{ij}$$

is used, it is often convenient to assume that the  $\beta_j$ 's are normal and independently distributed with mean 0 and variance  $\sigma_1$ . The  $\epsilon_{ij}$ 's are assumed to be normal and independently distributed with mean 0 and variance  $\sigma^2$ . Such balanced or partially balanced incomplete block designs are ordinarily arranged for the purpose of estimating the  $\tau_j$ 's.

If, however, the dual of the design used is also a known balanced, or partially balanced, incomplete block design, the interblock analysis is

simplified, and the ratio  $\mu = \frac{\sigma_1^2}{\sigma^2}$  may be studied.

This paper deals with the scheme used in the examination of such designs, and the cataloguing of those which are "nice" for interblock analysis.

## 18. A STUDY OF THE USE OF AN AUXILIARY VARIATE IN ANALYZING DISCRETE DATA.

R. J. Taylor and M. C. K. Tweedie; *Virginia Polytechnic Institute*.

It is often convenient to analyse discrete (or coarsely grouped) statistical data by formulae which would be exact only if the observed variates were continuous. This applies particularly to the calculation of probabilities in significance tests or confidence intervals when it would be preferable to know the applicable probabilities rather than merely some lower bound to them. This paper reports some results found in using an auxiliary random variable in conjunction with a variate transformation for data from Poisson distributions, approximately achieving both known probability levels and stabilization of variance.

## 19. A RESTRICTED OCCUPANCY CRITERION FOR TESTS OF CONSISTENCY AND INCONSISTENCY IN SUBJECTIVE RATINGS.

Arthur Norman Pozner; *Virginia Polytechnic Institute*.

A criterion derived from the assumptions of restricted occupancy theory is established for tests of consistency and inconsistency in subjective ratings based on a discrete scale of five subdivisions, ranging from *poor* to *excellent*.

Relationships are developed which permit the calculation of exact moments of the restricted occupancy distribution and a table of restricted occupancy coefficients is included for this purpose.



The criterion established is a comparison of observed rating frequency distributions with expected frequency distributions based on the assumptions of restricted occupancy theory.

A convergent continued fraction technique for the approximation of expected values is discussed in great detail.

Further research leading to the establishment of tests of significance is outlined.

#### NEW OFFICERS

The following new officers were elected:

*Chairman*, M. C. K. Tweedie

*Vice-Chairman*, John E. Freund

*Secretary*, Clyde Y. Kramer.

## LIST OF MEMBERS 1954-1955

Note: Following are the types of membership in the Academy.

**\*\*Patrons**, who contribute one thousand dollars or more to the Academy.

**\*\*Life Members**, who contribute one hundred dollars or more to the Academy.

**\*\*Honorary Life Members** (Elected by Council).

**\*Sustaining Members**, who pay annual dues of ten dollars.

**†Contributing Members**, who pay annual dues of five dollars.

*Regular Members*, who pay annual dues of three dollars.

*Student Members*, who pay annual dues of two dollars. (restricted to college students only).

Note: Number following name designates section, or sections, to which member belongs; "C" following name indicates "Student Member"; "B" following name indicates "Business Member".

- |  |                      |
|--|----------------------|
| 1. Agricultural Sciences                 | 7. Engineering       |
| 2. Astronomy, Mathematics<br>and Physics | 8. Geology           |
| 3. Bacteriology                          | 9. Medical Sciences  |
| 4. Biology                               | 10. Psychology       |
| 5. Chemistry                             | 11. Science Teachers |
| 6. Education                             | 12. Statistics       |

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